

EMPIRE COTTON GROWING CORPORATION

PROGRESS REPORTS FROM
EXPERIMENT STATIONS
SEASON 1948 - 1949

Price 3s. 0d., post free

LONDON
1950





Digitized by the Internet Archive
in 2025

**PROGRESS REPORTS FROM EXPERIMENT
STATIONS, SEASON 1948-1949.**

Price 3s. 0d., post free.

**Published by the Empire Cotton Growing Corporation,
12, Chantrey House, Eccleston Street, S.W.1.
1950**

CONTENTS.

	PAGE
CENTRAL RESEARCH STATION :	
Introductory Note	1
Genetics	2
SOUTH AFRICA : BARBERTON STATION :	
Introductory Note	8
Plant Breeding	13
Plant Pathology	17
Entomology and Physiology	26
UGANDA :	
Report of Senior Botanist	33
Kawanda Area	44
ANGLO-EGYPTIAN SUDAN :	
Introductory Note	52
Gezira Station	54
Shambat Station	61
Kadugli Station	68
TANGANYIKA TERRITORY :	
Lake Province	80
Eastern Province	93
NYASALAND :	
Introductory Note	98
Domira Bay Station	100
SOUTHERN RHODESIA : GATOOMA STATION	108
NIGERIA :	
Northern Provinces	118
Fertilizer Trials with Cotton	124
Entomology	126
Western Provinces	136
WEST INDIES :	
Introductory Note	138
Antigua Station	141
Montserrat Station	153
St. Vincent Station	158
AUSTRALIA : QUEENSLAND	166

CENTRAL RESEARCH STATION.

INTRODUCTORY NOTE.

This report covers the interim period between the closing of the Research Station in Trinidad in December, 1944, and Mr. F. R. Parnell's retirement from the Directorship of the new Central Research Station at Namulonge, Uganda, in October, 1949. Mr. F. R. Parnell who, to the Corporation's regret, had expressed his wish to retire on the score of age, was succeeded by Dr. J. B. Hutchinson. The conduct of research during this period was a matter of considerable difficulty, but the continuity of the Trinidad genetics work was maintained by posting Dr. Hutchinson temporarily to Shambat, in the Sudan.

Dr. R. A. Silow and Dr. S. G. Stephens resigned from the Corporation's service before the Trinidad Station closed down. Dr. Hutchinson took leave in England from November, 1944, to February, 1945, and then visited the Sudan and Uganda. A tour of the Sudan, Uganda, the Transvaal, S. Rhodesia, Nyasaland and Tanganyika followed during 1945 and 1946.

In September, 1946, the Sudan Government kindly made available a house, laboratory accommodation, and land at Shambat near Khartoum, and Dr. Hutchinson began at that Station the development of a new genetics programme. Dr. H. Douwes joined the staff at Shambat as Senior Cytogeneticist in August, 1947. Dr. Hutchinson was absent on a visit to West Africa from October, 1947, to February, 1948. Mr. R. L. Cuany joined as Cytogeneticist in September, 1948.

From 1944 to 1946 the chief task was to preserve the Cotton Research Station's living collection of the world's cottons, and that this was done successfully is due to the help given by the Corporation's officers working in the Sudan in the Cotton Breeding Section. In the 1944-45 season Mr. R. R. Anson and Mr. S. H. Evelyn grew part of the collection in Medani, and Dr. R. L. Knight a part at Shambat. In 1945-46 Dr. Knight grew the rest of the collection and some genetic material at Shambat, and he arranged for the recruitment and training of the Sudanese staff required when a fuller programme was undertaken in 1946-47.

Work at the new Station in Uganda during the period under review was restricted to erecting the laboratories, farm buildings and housing for European and African staff and to the preliminary clearing of land. The first Progress Report on experimental work on the Station will thus deal with the season 1949-50, at the commencement of which Mr. H. L. Manning transferred his BP.52 stocks from the Government Agricultural Research Station at Kawanda, where he had been working since 1945, and seed of the Upland type collection and of a staple length breeding project was sent from Shambat and planted at Namulonge.

A list of the staff who will be working at the Central Research Station during the 1949-50 season appears on the inside of the back cover of this volume.

REPORT ON GENETICS WORK, 1944-1949.

BY

J. B. HUTCHINSON, H. DOUWES AND R. L. CUANY.

I. *Type Collection.*

Seed of this collection was sent from Trinidad to Khartoum by air, and grown either at Medani or Shambat. Types which gave an adequate supply of seed in the Sudan were discarded in Trinidad, and those which failed in the Sudan were maintained in Trinidad until a fresh supply of seed could be sent. By the end of 1946 the transfer had been accomplished practically without loss. The only serious difficulty encountered in maintaining the collection at Shambat is the damage caused by leaf curl to the perennial types of *G. barbadense*. The *barbadense* collection will be grown in Uganda as soon as possible, and it is expected that adequate supplies of seed will then be built up.

The collection has recently been enriched by the acquisition of three long series of types from Central America. In 1946-47 Dr. S. G. Stephens collected in El Salvador, Guatemala, and Yucatán for the Corporation, and he arranged an exchange of material with Dr. T. R. Richmond of the Texas A. and M. College, who had collected in south-eastern Mexico the season before. These two series were grown at Shambat in 1947-48 and again in 1948-49. In 1948 Dr. Ware of the United States Department of Agriculture offered seed of a series collected by Manning and himself in eastern Mexico and Guatemala in the 1947-48 season, and this collection was also grown in 1948-49. The area covered by these collectors, is that in which *G. hirsutum* evolved, and in which it is most variable. Two seasons' studies have made possible a classification of the *hirsutum* material into a series of rather well defined geographical races, and the distribution of these, and their relations with each other, have yielded important information on recent differentiation within the species. A paper on intra-specific differentiation in the cottons is in preparation.

In the Sudan and during the West African visit, it was possible to study the distribution of all four species which contribute to the World's cotton crops in an area to which they have been introduced by man in comparatively recent times. The data thus collected supplemented information gathered from herbaria and from the reports of the Agricultural Departments of African territories, and made possible the compilation of an account of the introduction and spread of the cottons in Africa. This is now in the press.

2. *Genetic Investigations.*

Lint colour: The genetic programme was almost entirely closed down in Trinidad, but work on the distribution of lint colour in New World cottons was carried forward, and it is now possible to supplement the published information. Hutchinson (1946) gave data on brown linted Uplands which may be summarized as follows:—

Strain.	Main brown lint gene.	Intensifier.
Oaxaca brown UA 3-1 ...	Lc ₁ ^K	Lru
Mexican brown UA 3-5 ...	Lc ₁ ^K	Lru
Guatemala khaki UA 3-7 ...	Lc ₁ ^K	lru
Cauca mahogany UA 5-3 ...	single gene difference from white	
Gambia punctatum RA 8-1 ...	single gene difference from white, independent of Lc ₁ ^K	

Confirmation of these data was provided by F₂s of Oaxaca brown x Mexican brown, which gave brown only, and by Gambia x Mexican brown, which gave

Obs.	Rusty to clear brown.	Light brown.	White.	Total.
Exp. (12 : 3 : 1) ...	128	31	14	173
	130	32	11	173

To determine the position of the mahogany gene, Cauca mahogany was crossed with the other four browns, and F₂s were grown. Data are summarized in Table I.

TABLE I.

Lint colour segregation in Cauca mahogany crosses.

Cross.	Mahogany.	Rusty.	Clear brown.	Light brown.	White.	Total.
Gambia x Cauca mahogany Obs. ...	95	—	—	26	9	130
Exp. (12 : 3 : 1) ...	98	—	—	24	8	130
Oaxaca brown x Cauca mahogany Obs. ...	16	45	62	—	—	123
Exp. (12 : 3 : 1) ...	92	23	8	—	—	123
Mexican brown x Cauca mahogany Obs. ...	94	28	8	—	—	130
Exp. (12 : 3 : 1) ...	98	24	8	—	—	130
Guatemala khaki x Cauca mahogany Obs. ...	73	—	24	—	—	97
Exp. (3 : 1) ...	73	—	24	—	—	97

The distinctions between classes were good in the Gambia and Guatemala khaki crosses, but poor in those involving Oaxaca brown and Mexican brown. The relationships of the genes, however, are quite clear. Mahogany and *punctatum* brown are at different loci, and give a clear segregation in F₂ into 12 mahogany : 3 *punctatum* light brown ; 1 white. Mahogany and the Lc₁^K of Guatemala khaki, on the other hand, are allelic, giving 3 mahogany : 1 clear brown. Oaxaca brown and Mexican brown, which also carry Lc₁^K, gave no whites in crosses with mahogany, but the segregation between mahogany and clear brown was obscured by the presence of the rusty intensifier Lru. The symbol Lc₁^M may be assigned to the mahogany gene.

Blackarm and leaf curl resistance: In 1946 Dr. R. L. Knight suggested that the whole type collection should be surveyed for resistance to blackarm and leaf curl. This was done in the 1947 and 1948 seasons, and papers embodying the results obtained are in the press. The information obtained will be of great value in the future planning of breeding work, and may be regarded as the first fruit of the Corporation's policy of bringing genetics and plant breeding into close association.

3. *Cytogenetics.*

In Trinidad Dr. Stephens treated with colchicine a seedling of the hybrid *G. thurberi* x *G. arboreum* AN 1. It subsequently appeared that at least one branch of the plant had become tetraploid, and when it flowered it was pollinated with U.4 (Upland) and Sea Island pollen. The hybrid seed was forwarded to the Sudan, and with it came seed from one self pollinated boll. As all previous *G. thurberi* x *G. arboreum* tetraploids had been male sterile this was unexpected, but the resulting progeny was undoubtedly self-bred, and a slightly fertile line has been established. Of the two F_1 progenies, that with Sea Island was normal and fertile, and has yielded extensive material that is now being analysed by R. L. Cuany. The U.4 cross gave dwarf unthrifty F_1 plants, only one of which produced a flower. Subsequently a cross of the tetraploid by the Upland strain MU.8b also gave dwarfs that failed to flower in F_1 , and the backcross (tetraploid x Sea Island) x MU.8b gave

27 normal : 34 dwarf

Evidently there is a single gene in the tetraploid which is responsible for dwarfing when combined with the genotype of the Uplands U.4 and MU.8b.

In 1945 two accessions were obtained of the little known wild species *G. somalense*. One was collected by Mr. D. K. Kevan near El Wak in the Juba valley, Somaliland, and the other was found by Dr. R. L. Knight on Gebel Merkhyat, not 10 miles from Shambat. On morphological grounds the species was regarded as a relative of *G. stocksii*. Crosses were made between *G. somalense* and *G. anomalum* without much difficulty, but the *G. somalense* x *G. stocksii* cross was not easy to obtain. It was finally made by Dr. H. Douwes, and he has studied the cytology of all combinations of the three species *G. somalense*, *G. stocksii* and *G. anomalum*. His findings have been submitted for publication elsewhere, but briefly the chromosome number of *G. somalense* is $n = 13$, and its genom exhibits a high degree of homology with that of *G. stocksii*, and is practically non-homologous with that of *G. anomalum*.

Dr. Douwes has commenced the exploration of the cytological situation in hybrid polyploid material bred by Dr. Knight for his gene transference work. He has demonstrated the instability of the hexaploids "*armadense*" and "*thurbadense*" under conditions of natural pollination, and has also shown that a seedling of *G. barbadense* x *G. klotzschianum* var. *davidsonii*, treated with colchicine by Dr. Knight, was a hexaploid.

An important experiment now in progress is the attempt to synthesize tetraploids homologous with New World cottons by doubling the chromosome number of hybrids between Old World (diploid) cottons and the wild New World diploid *G. raimondii*. The cross is not easy to make, but Dr. Douwes has succeeded in obtaining a few seeds. Meanwhile, in order to ensure the greatest possible

chance of making the polyploid, he has carried out a systematic study of the response of an Asiatic cotton to varying dosages and lengths of treatment with colchicine. His results, which will be written up in due course, will improve the efficiency of colchicine treatment of cotton, especially with difficult hybrids.

Seed of *Gossypium gossypoides* was received with the Central American collection, and plants have been grown and the chromosome number determined ($n = 13$) by R. L. Cuany. Crossing with this species is in progress, with a view to determining its relationships.

R. L. Cuany is studying semi-sterile rogues that occur not infrequently in commercial Sakel crops, and a sterile segregate from an Upland x Egyptian cross that appears to be similar to the asynaptic segregate reported by Beasley (1942).

4. Lint Development Studies.

Studies of the developmental morphology of cotton lint have been undertaken by the Botany Department of Manchester University. Material is collected and preserved at Shambat, and forwarded by air to Manchester for examination.

PAPERS COMPLETED OR IN PREPARATION.

- J. B. Hutchinson. Notes on the classification and distribution of genera related to *Gossypium*.
- J. B. Hutchinson. The dissemination of cotton in Africa.
- J. B. Hutchinson. On intra-specific differentiation in the cottons.
- R. L. Knight and J. B. Hutchinson. The evolution of blackarm resistance in cotton.
- J. B. Hutchinson and R. L. Knight. Response to leaf curl disease in cotton.
- H. Douwes. The cytological relationships of *Gossypium somalense*.

REFERENCES.

- Hutchinson, J. B. (1946). The inheritance of brown lint in New World cottons. *J. Genet.* 47, 296.
- Beasley, J. O. (1942). Asynaptic *Gossypium* plants and their polyploids. *J. Ag. Res.* 65, 421.

PROGRAMME.

With the departure of Dr. J. B. Hutchinson for Uganda, the genetic and cytological work has become a part of the programme of applied genetics already in hand, and the integration of genetics and plant breeding will be carried a stage further. As a record of the type of work which it is agreed would be carried on in the Sudan as part of the Corporation's long range research, the following programme has been compiled in consultation with Mr. R. R. Anson, Chief Cotton Breeder, and Dr. R. L. Knight, Senior Economic Geneticist, who will supervise the work.

1. Cytogenetics.

- a. Studies of the polyploid series used in gene transference for plant breeding purposes.
 - Tetraploid Asiatic x New World cultivated.
 - Hexaploid (New World wild x cultivated).

- b. Synthesis and genetic study of new tetraploids from crosses of Asiatic cottons x New World wild species.

Asiatic x *raimondii*

Asiatic x *gossypioides*

Asiatic x *thurberi*

Asiatic x *armourianum*

It is hoped to show that the Asiatic x *raimondii* tetraploid is closely related to New World cottons, and that the other three polyploids form a series with decreasing homology in the D set. The Asiatic x *thurberi* polyploid is available, and genetic and cytological studies are in progress.

- c. Cytology of wild species of *Gossypium* and related genera. A study of *G. somalense* and its closest relatives has been completed. *G. gossypioides* is under examination. *G. triphyllum* has been received recently, and it is hoped to obtain *G. areysianum* from Aden as soon as a favourable season occurs.* Studies of these species are important to complete our knowledge of the genus, but do not take up a great deal of time.

Species of *Thespesia* and *Cienfugosia* are available, and chromosome numbers will be determined as opportunity offers.

2. Genetics.

- a. Genetics and (if necessary) cytology of rogues in Egyptian cotton.

Two types of rogues occur in the Gezira crop, tall steriles and very vigorous, highly productive types. The latter are regarded with some confidence as inter-specific F_1 s, probably with *punctatum* (Hindi weed). When sent in, they will be grown and looked at, and if the diagnosis is confirmed, they will not be studied further.

The steriles are undoubtedly of pure Egyptian origin. In Sakel, most of those observed are completely sterile, but a few open pollinated seeds have been collected on occasional plants.

In 1730, sterility is usually incomplete, and one or two poor bolls can be collected from most plants. Four F_2 s from a 1730 rogue collected by Mr. Evelyn were grown in 1948-49, and natural seed from a number of rogues in the 1948-49 commercial crop are growing out-of-season in early 1949.

- b. Genetics and testing of blackarm resistance.

Dr. Knight has explored the field of blackarm resistance with special reference to the practical breeding of resistant strains. The practical importance of the group of genes which he discovered is such that they form an excellent

* Seed of this variety has now been received.

object of study by a team engaged in developing the application of genetics to plant breeding.

The following specific projects are proposed :—

1. Detailed assessment of the linkage demonstrated by Dr. Knight between B_2 and B_3 . Identification of the cause of the reduction in crossing over recorded by Dr. Knight, and a survey of the distribution of different types of B chromosome, if such differences are demonstrated.
 2. Search for linkages with B genes to facilitate homology studies.
 3. Tests of the basis of resistance in
 - a. Highly resistant West African stocks.
 - b. Resistant Acala UA2-15 and Stoneville 20.
 - c. Bahamas *punctatums*.
 4. Transfer of B_2 and B_3 to B.P.52 and Wilds 16.
 5. Sorting breeding stocks for other African territories.
- c. Genetics of hairiness.

This is a major item on Dr. Knight's programme for the breeding of jassid resistant Egyptian cottons. The Cytogeneticists will assist as required.

- d. Linkage relations in Asiatic cottons.

Data on linkage values are of importance in connection with recent theories on the nature of species differences. It is proposed to study two linkage groups in Asiatic cottons

$Lc_1^K—Li_d—Cu—L$
and $P—Ne$

for comparison with the $B_2—B_3$ group in New World cottons. The Asiatic blackarm resistance gene B_4 will be tested against both groups.

- e. Miscellaneous.

A few minor experiments are in progress. An attempt is being made to transfer lint to *G. anomalum*, and cytological and genetic studies are in progress on a sterile (asynaptic) segregate from an Egyptian x Upland cross.

3. Type collection.

Maintenance of the type collection and seed exchange with cotton breeders is a matter of routine. Seed stocks will be renewed not less frequently than once in seven years.

SOUTH AFRICA.

COTTON EXPERIMENT STATION, BARBERTON.

PROGRESS REPORT FOR THE SEASON 1948-1949.

INTRODUCTORY NOTE

BY

D. MacDONALD.

Staff :

Mr. H. E. King, a member of the staff of the Sudan Agricultural Department who had been working at this station on secondment since July, 1942, proceeded on overseas leave early in December, 1948, prior to joining the staff of the Corporation as Senior Cotton Breeder in Nigeria, with the approval of the Sudan Government.

Dr. R. C. Rainey who had been absent from the Station since December, 1946, first on overseas leave, and then on temporary secondment to the Anti-Locust Research Centre, returned to duty in October, 1948. Dr. Rainey subsequently resigned from the Corporation's staff and accepted the post of Senior Entomologist with the Desert Locust Survey.

Mr. J. M. Munro was transferred to Tanganyika in December, 1948.

Mr. C. E. Booth, the chief field assistant, resigned in August, 1948, in order to take up an appointment with the Sugar Research Association, Mount Edgecombe, Natal.

Visitors :

Mr. J. Littlewood, Chairman of the Council and of the Executive Committee of the Corporation and Mrs. Littlewood, spent the first week in May, 1949, in Barberton inspecting the work being carried out on the Station, and meeting cotton growers in the area.

Dr. M. S. du Toit, Assistant Secretary for Agriculture, and members of his staff, visited the Station in order to discuss the handing over of the Station to the Union Government's Department of Agriculture at the end of the season's work.

The Berg River Textile Industries are erecting new spinning mills in the Cape Province, and three of their directors visited the Station in order to get information on the lines of work being carried out by the Corporation's Staff, and on the grade and amount of cotton produced in the Low Veld of South Africa.

TRANSFER OF THE COTTON EXPERIMENT STATION TO THE UNION GOVERNMENT.

The programme of work on cotton carried out during the 1948-49 season was considerably reduced compared with that of previous seasons on account of :—

- (a) The transfer of Mr. H. E. King and Mr. J. M. Munro and the resignation of Mr. C. E. Booth.
- (b) The time which had to be devoted to preparations for handing over the Station to the Union Government and to consequent discussions with officials of the Department of Agriculture ; to arranging for the despatch to Uganda of some of the scientific equipment, and the sale to the Union Government of the rest and of the live and dead stock on the Station ; further, steps had to be taken to ensure that the housing site was proclaimed a new extension of the existing Township of Barberton, in order that the houses might be sold individually.

The South African Department of Agriculture has appointed Professor A. R. Pullen to take charge of future work carried out on the Station. The arrival of Professor Pullen in Barberton three months before the departure of the writer, enabled him to get first-hand knowledge of all the lines of work which had been carried on at the Station in previous years, as well as providing the opportunity for discussion of suggested future lines of work which could profitably be attempted.

Broadly speaking, the lines of work suggested fall under three heads.

(1) *Continuation of the cotton breeding work* carried on in past years by the Corporation's Staff in an attempt to improve still further the yield per acre and quality of lint from strains already bred, together with further work on the control of cotton pests and diseases. For the furtherance of this work, ample seed supplies of both proved and promising strains of cotton, mainly of hybrid origin, already bred by the Corporation's Staff, have been handed over to Professor Pullen.

(2) *The breeding of Streak resistant maize.* The breeding of strains of maize resistant to " Streak " was begun by the Corporation's Staff at Barberton before the beginning of the last war, but since the outbreak of war, shortage of staff prevented the continuation of detailed work on maize. In recent years " Streak " disease of maize has spread to areas outside the low veld where previously it was practically unknown, and is now becoming of major importance in middle and particularly late season plantings.

The place occupied by maize production in the farming economy of South African Agriculture is important and further work on the breeding of " Streak " resistant strains at the Barberton Station, where the disease is present every season, offers great opportunities to the plant breeder.

(3) *Pasture Research.* Much of the low veld of South Africa is essentially good cattle country, and pests, particularly Red bollworm and stainer, together with a precarious rainfall, make cotton growing uneconomic, except possibly in times of boom prices. At present the number of cattle per acre that this area is capable of carrying is low, but it possesses a wealth of good indigenous grasses, and the judicious sorting out and propagation of the best types would enable the carrying capacity of the area to be vastly increased.

Work in this direction is most important, not only on account of the general world shortage of meat, but also because at present South Africa does not produce sufficient meat to meet the increasing demand of both the European and native population of the country.

It is not anticipated that the above lines of work can be developed in full in the immediate future, as South Africa, like all other countries within the Commonwealth, is suffering from a shortage of trained scientific staff, and it will be some time before Professor Pullen will be able to fill adequately the staff requirements of the Station.

Nevertheless it is satisfactory to record that continuity of the lines of work begun by the Corporation at Barberton, though for the present it may be on a limited scale, is assured by the appointment of Professor Pullen. The author wishes to place on record his appreciation of the assistance given by Mr. Pieter Koch, Chief Technical Fibre Adviser to the Department of Agriculture, in the transfer of the Station and in ensuring, despite difficulties due to staff shortage, that continuity of the work on the Station should proceed.

SUMMARY OF SEASON'S CONDITIONS.

<i>Planting Dates.</i>	<i>Picking Dates.</i>	<i>Legal Close Season.</i>	<i>Rainfall.</i>	<i>Mean Temperatures.</i>
21st October ... 5th-12th November	May to August	30th September	26.11 inches	1/11/48-30/4/49 Max. 83.7°F. Min. 62.3°F.

The breeding programme for the final season of the Corporation's work at Barberton was reduced to a lesser scale than that of previous seasons for reasons already mentioned, and apart from these reasons, lack of rainfall limited the amount of material which could be planted. The total rainfall for the season, namely 26.11 inches, though below the average for the last 20 years would have been sufficient to produce a heavy crop if it had been well distributed.

The season opened well with good October rains which enabled the preparation of seed beds to be carried out on winter ploughed land. Cotton planting was begun on October 21st, but a heavy storm of .87 inches on October 22nd, followed by hot dry conditions, caused crust formation on the planted land, with the result that the stand obtained was so poor that replanting was necessary. Good stands were obtained from the main planting carried out between 5th and 12th November, but from then until 18th January no effective rain fell, with the result that the growth and development of the cotton crop was severely retarded, while early planted maize was killed.

The harmful effect of this long drought on the normal growth of the cotton crop was further accentuated by a heavy aphid attack which persisted throughout December and early January, so that when the drought broke in mid-January, the average height of the cotton plants was from 10 to 12 inches.

Following the break in the drought, growth was rapid and after 10.62 inches of rain had fallen between 18th January and the end of February the rainfall for the remainder of the season though not heavy was, in conjunction with the reserve of subsoil moisture established in February, sufficient for the requirements of the crop. In addition temperatures remained high until late in the season thus ensuring that late set bolls matured and opened satisfactorily.

Bollworm infestation during the season was light being confined to a small infestation of American bollworm during February, while the stainer population was the smallest recorded for many years. On the other hand jassid infestation was one of the most severe ever observed on the Station, and though the majority of the good hybrid strains exhibited full resistance, U4 strains which are normally resistant showed, as in season 1947-48, some jassid "damage" when grown alongside susceptible strains.

While it was possible to find in the crop the leaf rolling caterpillar, *Sylepta derogata* F., recorded for the first time in South Africa in the previous season, the damage caused by this insect was negligible.

The incidence of *Xanthomonas malvacearum* in the cotton crop was very much less than that of the previous seasons, but the spread of *Verticillium* wilt throughout the station lands continued. Details of the incidence of these diseases are given by Dr. Wickens in his section of this report.

Verticillium wilt was first identified on the Barberton Cotton Station in the late thirties, but it was not recorded on the outside farms in the district until season 1946-47, when it was found on two farms. During the present season the disease was recorded on four further farms in the Barberton area. Furthermore the disease has been identified this season from many plant specimens forwarded from Magut, and the indications are that the disease is spreading to many lands in the Magut area where it has not previously been recorded. If the disease continues to spread it will constitute a major breeding problem in the future, as all the strains at present in general cultivation are susceptible to *Verticillium* wilt.

Owing to the high prices commanded by both lint and cotton seed in South Africa, relative to other crops apart from tobacco, the acreage under cotton in the low veld this season was expected to be a record but the drought experience on the station was common throughout South Africa, and severely limited the actual acreages which could be planted. Nevertheless the output of the Barberton Ginnery is expected to exceed 5,000 bales of lint, an output more than double that of the previous season. Despite the drought in the early

season good rains from the latter part of January onwards, coupled with freedom from pests and the late advent of low temperatures, enabled late-set bolls to mature with the result that in many cases yields of 1,000 lb. seed cotton per acre and upwards were obtained on individual farms.

The season's crop has been sold at prices ranging from 1s. 6d. to 1s. 7d. per lb. lint and £13 per ton seed, both prices being F.O.R. Barberton. These prices, along with the fact that the four spinning factories established, or in process of being established in South Africa, are capable of consuming far more cotton than the country can hope to produce, will tend to stimulate increased production during the coming season provided that climatic conditions are favourable.

LEGAL CLOSE SEASON.

The advantages of a close season in which all cotton plants have to be uprooted by a given date, thereby preventing the cultivation of ratoon or standover cotton, has long been recognised as an important factor in the control of pests and diseases in most cotton growing countries. The advantages of such a close season in South Africa on the control of pests, particularly Red bollworm and stainers, were fully recognised by the Corporation's staff, but until recently a special Act of Parliament was required for the legal establishment of such a close season, and it was not found possible to get a special Act passed.

Fortunately an Act recently passed dealing with the Control of Pests and Diseases of Cultivated Plant and Orchard Crops, offered the opportunity for growers to obtain a legal close season for cotton by means of expressions of local option, provided that a two-thirds majority vote in favour of the motion is carried.

In June a meeting of all cotton growers in the area along with representatives of the Corporation's Staff was convened by the local Magistrate in order to discuss the establishment of a legal close season for cotton. After discussion it was unanimously decided that a close season for cotton should be established, and that all cotton grown in the Barberton Magisterial area should be uprooted and destroyed by the 30th September of the current season.

At present this close season will only apply to cotton grown in the Barberton Area, but it is confidently anticipated that cotton growers in other areas of South Africa will follow the example set by Barberton.

While the date fixed is later in the season than the author of this report recommended in order that the maximum benefit could be derived from a close season, the actual date fixed for uprooting and destroying all cotton plants can be altered from season to season. No matter what date is fixed for any particular season, the fact that a legal close season has been established will ensure the prevention of ratoon and standover cotton, and this should be of major importance in the control of Red bollworm and stainers.

PLANT BREEDING SECTION.

BY

D. MacDONALD.

GENETICS AND BREEDING.

Variety Trial. A replicated 16 strain variety trial was planted consisting of hybrid lots derived from U.4/8161 $\times$ Sea Island and MU.8 $\times$ BP.52² material, together with A.2106, U.4/5143 and BP.52 as controls. The seven strains derived from U.4/8161 $\times$ Sea Island and the six from MU.8 $\times$ BP.52², were all derivatives of strains which had showed great promise in the two previous seasons, which were generally speaking good ones, with an ample and well distributed rainfall.

The trial was planted on November 5th, the germination being excellent, and the resulting good initial stands despite the early season drought, were retained throughout the season.

Growth during the first fortnight following germination was good, but the drought which began in mid-November and continued until after the middle of January, was so severe that growth was severely checked. In addition a severe aphis attack which began in early December and persisted throughout the dry period was an added check to the normal development of the crop, with the result that very few plants had attained a height of 12 inches when the drought ceased.

Following the January rains all strains made a good initial recovery, and the earliness as regards fruiting was particularly noticeable in the Sea Island group of crosses. Unfortunately this early flush of fruiting coincided with a short attack of American bollworm, which though not particularly heavy was sufficient to account for most of the early crop produced by the Sea Island crosses, while doing considerably less damage to the other strains, which being later in producing the initial flush of fruiting, thereby escaped with a little loss of crop.

While the initial recovery of all strains was good, later crop production showed wide differences between the different groups, and by March it was obvious that, probably due to the relative effect of the severe early drought on the vitality of the strains, the recovery of the Sea Island group of crosses and of BP.52 was not as good as that of the MU.8 $\times$ BP.52² crosses or of U.4/5143 and A.2106. This field observation was proved by the final picking figures which showed that the yields of lint per acre of all the U.4/8161 $\times$ Sea Island strains and of BP.52 also were significantly lower than that of all the other strains included in the trial.

TABLE I.
SUMMARY OF RESULTS OF VARIETY TEST 1948-49.

Strain.	Gin %	Seed Weight.	Lint Length.	Yield lb. lint per acre.
A.2106	36.5	11.7	32.0	629
U.4/5143	36.3	9.9	29.6	463
BP.52	32.5	10.4	33.7	322
Best M.U.8 × BP.52 ² strain A.7262	35.3	10.5	34.4	479
Mean of 6 M.U.8 × BP.52 ² strains	35.4	10.6	34.3	465
Best U4/8161 × Sea Island strain A.7862	35.2	11.4	37.6	366
Mean of 7 U.4/8161 × Sea Island strains	33.2	13.1	36.2	281

Diff. required for significance $P = .05$ 31.8 lb. lint per acre.

The Cambodia × U.4/5143 hybrid A.2106, as in all previous seasons irrespective of conditions, again gave the highest yield of lint per acre, and its yield of 629 lb. lint per acre was significantly higher than that of all other strains in the trial. Of the six MU.8 × BP.52² lots, three gave better though not significantly higher yields than U.4/5143, but all of them gave significantly higher yields than BP.52 and all the U4 × Sea Island strains in the trial.

While significant differences between the yields of the different U.4 × Sea Island strains showed up, it was evident that their powers of recovery in general from severe drought, even if allowance is made for damage by bollworm to the early fruit, was not nearly as good as that of the MU.8 × BP.52² strains.

For the second consecutive season, under good and bad conditions, the best MU.8 × BP.52² strains have only been out-yielded by A.2106. That they have done so well in this season's drought is particularly pleasing, as drought resistance is of paramount importance in any strain under low veld conditions. While the yields of lint of the best derivatives of this cross are less than that of A.2106, and only slightly superior to that of U.4/5143 the quality of their lint as judged on their spinning test is much better than either A.2106 or 5143.

During Mr. Littlewood's visit to Barberton he was favourably impressed by the quality of the lint of the MU.8 × BP.52² crosses, and by his courtesy arrangements have been made for large scale spinning tests to be carried out on 2,000 lb. samples of lint of both A.2106 and on MU.8 × BP.52², at Ladysmith, Natal and in Lancashire.

Progeny Line Re-selection Work. Some 8 acres of progenies of single plant selections, made in the previous season from the MU.8 × BP.52² and U.4/8161 × Sea Island hybrid groups, were planted. Many, though not all of these progenies, were closely related to the strains in the variety test, and generally speaking the differences in field behaviour between the two groups due to the season's conditions, were similar to those shown by them in the variety test.

The standard of jassid resistance was regularly very good in both groups, and that this absence of signs of jassid damage was not due to lack of jassids was amply demonstrated by the fact that adjacent plots of BP.52 and U.4/5143 showed visible signs of jassid "effect." Boll

opening within the Sea Island crosses was regularly good, but in some progenies within the MU.8 $\times$ BP.52² lots a small proportion of plants exhibiting "bunch" or "cluster" type of fruiting associated with less good opening still persisted.

As the limited amount of time available between the opening of the crop and the handing over of the Station to the Union Government did not permit of laboratory analysis of the normal large numbers of single plants, selection in both groups was confined to special bulks of large numbers of plants in the most promising progenies in both groups of crosses, particular attention being given to good opening types in the MU.8 $\times$ BP.52² group.

Laboratory analysis of these bulks showed that while the lint lengths of the Sea Island crosses, ranging from 35 to over 38 mm. were generally better than the MU.8 $\times$ BP.52² crosses their ginning percentages were variable, and on the average not so high as that of the later groups of crosses. The average plant yield of the MU.8 $\times$ BP.52² bulks was regularly good and considerably higher than those of the other cross.

Observation Plots.—It has normally been the custom to plant observation plots, of strains which have shown good promise in tests carried out on the Experiment Station, on outside farms in order to get a line on their behaviour when grown under a range of conditions. Accordingly a MU.8 $\times$ BP.52² derivative A.618, which in the main variety test of season 1947-48 had given a yield of lint per acre higher than any strain other than A.2106, and in addition had proved in spinning tests that its lint was considerably superior to that of A.2106, was planted on two outside farms.

A three-acre plot of A.618 on Mr. A. N. de Maine's farm was planted late on account of drought, the resulting stand being rather poor. A heavy bollworm attack in mid-season damaged the crop severely, but in spite of these difficulties the average yield per acre exceeded 1,000 lb. seed cotton.

On Mr. S. N. Spear's farm an eight acre block of the same strain was planted early, on old tobacco land which had been well fertilized during the previous season. Rainfall conditions on this farm in the early part of the season though not good were better than the average for the district, as a fall of approximately an inch of rain in late December partially reduced the effect of the November-January drought. Damage to the plot by pests and diseases during the entire season was negligible, the final yield figures being approximately 2,500 lb. seed cotton per acre.

A.618 like other MU.8 $\times$ BP.52² strains has given consistently high yields of lint per acre under varying conditions in past seasons, and while it is not anticipated that it will ever out-yield A.2106, the strain at present in general cultivation in the low veld, it possesses the following advantages over A.2106.

(1) Earliness is an important factor in any strain of cotton grown in the low veld, and A.618 is slightly earlier than A.2106.

(2) A.618 is, judged by the number of leaf lamina hairs per sq. cm. at .5 mm., more jassid resistant (mean of 12th and 16th leaf: A.618, 181; A.2106, 139).

(3) The lint of A.618 as judged in spinning test results is superior to that of A.2106.

If the difference in price commanded by the better quality A.618 lint is sufficiently great to outweigh the superior yield of A.2106, the question of replacing A.2106 by A.618 will have to be considered.

WILD COTTONS.

The five species of wild cotton supplied from the Sudan collection and planted in season 1947-48 were allowed to grow under controlled conditions as standover cottons. The early season's drought affected all the species, and practically no fresh growth took place until after the January rains. Even after the rains *G. armourianum* plants were obviously unsuited to local conditions, and by the end of the season practically all the plants of this species were dead, while the few plants which still survived made no attempt to fruit.

All the other species grew and fruited well and, apart from *G. raimondii*, were unaffected by pests and diseases. Growth of *G. raimondii* following the January rains was extremely vigorous and by late May and early June it was setting an abundant crop, when it was suddenly attacked by *Alternaria*. In less than a fortnight all plants were completely defoliated by the disease and all fruit already produced shed.

ROTATION CROPS.

Maize constituted the main crop other than cotton grown on the Station. Normally early planted maize on the main Station lands will average over 2,000 lb. grain per acre, but during the current year the effects of the drought on early planted maize reduced yields per acre to under 400 lb. of grain.

The bulk of the maize was, on account of drought, planted late in the season and consisted largely of the Streak resistant Peru × Hickory strain, which had previously proved itself capable of yielding well in a short season.

The incidence of Streak was not so high as that of the previous season on the Station, but the demand for Streak resistant seed from farmers was again greater than the supply available.

Tepary and Soya beans yielded poorly, but a small acreage of early planted groundnuts demonstrated the excellent drought resisting powers of this crop.

PLANT PATHOLOGY SECTION.

BY

G. M. WICKENS.

The season's programme, already curtailed in anticipation of staff limitations and of distractions imposed by the closing down of the Barberton Station, was unfortunately further restricted by the complete failure of one planting, owing to the severe drought of December and early January. Because of this, studies of the reactions of parental and hybrid strains to artificial inoculations with *Verticillium dahliae*, and studies of inoculation methods, had to be abandoned.

Natural incidence of pests and diseases was low, except for wilt in previously affected areas and one unusually severe attack by *Syagrus* beetle that required hand collection and DDT spraying for effective control.

VERTICILLIUM WILT DISEASE.

Distribution, spread, and carry-over of infection.—Wilt incidence was mapped in plots to which plant sanitation treatments had been applied in 1947-48. These treatments consisted of two types of roguing during the season, and of various methods of stalk and debris removal when the season was over. Roguing was generally done twice weekly, occasionally once weekly, from the first appearance of the disease until senescence. No plant showing external symptoms of the disease remained in the rogued plots for more than 4 days, except for 3 exceptional occasions when the maximum was 7 days. The treatments applied were as follows:—

TABLE I.

Treatment No.	Disposal of affected plants (during the season).	Disposal of stalks (after the season).
1 (control).	Left <i>in situ</i>	Chopped out at ground level and burnt (normal agricultural practice).
2	Cut off at ground level and removed as they appeared, together with their fallen leaf.	Chopped out at ground level and burnt, with sweepings of plant debris.
3	Pulled out by the roots and removed as they appeared, together with their fallen leaf.	Pulled out by the roots and burnt, with sweepings of debris.
4	Left <i>in situ</i>	Chopped out at ground level and burnt. Plant debris swept off.
5	Left <i>in situ</i>	Chopped out at ground level and burnt. Debris left <i>in situ</i> , and that swept from (4) added.
6	Left <i>in situ</i>	Pulled up and burnt. Plant debris swept off.
7	Left <i>in situ</i>	Pulled up and burnt. Plant debris left <i>in situ</i> , and that swept from (6) added.

Plant debris was mostly fallen leaf, but twigs and shed fruiting material were also present.

Incidence of disease (external symptoms) in these plots in 1947-48 and in 1948-49 is given in the following table (Table II). The percentage of plants that contracted disease in 1948-49 on sites more than two-removed (including knight's moves) from infected sites of the previous season may be taken as an index of spread, and this index is recorded in the last column.

TABLE II.

Treatment.	No. of plots.	Disposal of			% plants showing symptoms		Index of spread.
		Affected plants.	Stalks.	Debris.	1947-48.	1948-49.	
1	1	Left ...	Chopped out	Left ...	31.8	22.1	6.1
2	1	Cut off ...	Chopped out	Removed ...	32.8	11.1	0.0
3	2	Pulled out ...	Pulled out ...	Removed ...	33.3	9.2	0.0
4	5	Left ...	Chopped out	Removed ...	20.8	19.8	2.3
5	4	Left ...	Chopped out	More added.	31.6	40.9	13.3
6	5	Left ...	Pulled out ...	Removed ...	25.9	21.6	2.3
7	4	Left ...	Pulled out ...	More added	21.6	35.3	8.3

It will be seen that in plots from which debris was removed there was less wilt in the following season, and the wilt which occurred was more closely confined to sites affected in the previous season, than in plots on which debris was allowed to remain, or to which more was added (treatments 2 and 3 vs. 1, 4 vs. 5, and 6 vs. 7).

Notwithstanding thorough removal of sources of infection (3), some infestation persists to cause infection in the following season. This infestation is very little, if at all, disturbed in position by cultivation or by natural agencies. In the 10 plots from which leaf debris had been removed by sweeping (4 and 6), incidence of disease was rather uniformly similar to that in the previous season. In contrast, the 8 plots of treatments 5 and 7 were very variable in this respect; in 3 of them disease incidence was similar in the two seasons, while in the others it was to a varying degree greater in the second season. It appears therefore that leaf debris *may, but does not necessarily,* result in increase of disease in the following season. Presumably some additional soil factor is necessary.

Influence of compost, potash and superphosphate on wilt incidence and on yield under wilt conditions.—Compost (C), nil and at the rate of 10 short tons per acre, potash (K), nil and at 400 lb. KCl. per acre, and phosphate (P), nil and at 500 lb. superphosphate per acre, in all combinations, were applied in 4-fold randomised replication (except treatment nil given to 8 plots) to 36 plots coincident with 36 blocks of the wilt variety trial of 1946-47, in July 1948. Blocks were arranged according to previous wilt incidence rather than topographically. The experimental area, of about 2.4 acres, was planted with the susceptible strain U.4/5143, at normal 3 ft. $\times$ 2 ft. spacing. Wilt incidence for comparison with that suffered previously in the variety trial of 1946-47, and yield of seed cotton, were recorded for each plot, exclusive of between-plot guard rows, giving main results as summarised in Table III.

TABLE III.

Treatment.	% plants showing external symptoms of wilt.		Yield of seed cotton.			
	Season 1946-47 (113-120 days after planting).	Season 1948-49 (103-104 days after planting).	In this experiment.		In adjoining experiment under virtually wilt free conditions.	
			lb./acre.	% of control.	lb./acre.	% of control.
Nil	7.8	21.6	326	100	750	100
P	8.9	27.5	207	65	715	95
C	10.8	32.8	917	293	1323	176
CP	9.7	36.1	854	273	1408	187
K	9.5	30.2	1000	319	1063	142
PK	5.9	24.9	796	254	1270	169
CK	7.3	36.4	1174	375	1541	205
CPK	9.9	32.3	1282	410	1669	222

There has clearly occurred a marked general increase in wilt incidence from season 1946-47 to season 1948-49, even when allowance is made for the fact that in the former season 2 of the 11 rows of each plot were of varieties showing some resistance to the disease. (Maize was the intervening crop).

Statistical analysis has yielded no evidence of difference between manurial treatments in respect of the incidence of wilt in 1948-49 as compared with that in 1946-47, nor of any association between wilt incidence and plant nutrition and development. All the evidence obtained so far indicates that the association between factors affecting wilt incidence and soil fertility, arises through the effect of the latter on carry-over, persistence, and increase of soil infestation by the pathogen, rather than by direct effect on host nutrition and development.

Yields of seed cotton were compared with those obtained from a duplicate manurial trial carried out on a neighbouring wilt-free field (see Table III). The wilt-affected field appeared to suffer rather more from drought than the other, and this doubtless contributed to the difference in yield level between the two trials.

Yields of seed cotton under treatments nil and superphosphate only were very low. Compost and potash, both independently and in combination, gave very large yield increases, in both the wilt-affected and the parallel wilt-free experiments. Proportionally, however, the yield increases from compost and potash were much greater in the wilt experiment than in the healthy trial. It appears, therefore, that the crop withstood the effects of the disease better at a high level of nutrition than at a low level.

Variety trial.—This experiment was designed to evaluate the relative reaction of the strains and hybrid progenies, listed in Table IV, to natural infection by *V. dahliae* in the field.

The experimental design was the same as that employed in the variety trial of 1946-47, the strains being randomised in 1-row plots

of 37 hills at 3 ft. $\times$ 2 ft. spacing, each having on either side a row of susceptible control (M.U.8A being thus used in this instance). The experiment comprised 20 blocks, coincident in site with 20 blocks of the variety trial of 1946-47.

In common with the rest of this area, these 20 blocks showed a marked increase of severity of disease above that of season 1946-47; maize was the intervening crop in 1947-48.

Table IV summarises analyses of data for % wilt in the 6 strains, transformed to $\sin^{-1}\sqrt{\%}$ wilt and "adjusted" by covariance analysis with $\sin^{-1}\sqrt{\text{mean } \%}$ wilt in adjoining control rows.

TABLE IV.

	MU.8A	BP.52	B.181	A.7834	A.791	A.7261	S.E.
Degrees (mean)	56.75	33.95	29.70	47.05	48.75	55.23	± 1.68
% wilt (mean)	69.9	31.2	24.5	53.6	56.5	67.5	

In resistance to wilt as indicated by the proportion of plants in this experiment showing external symptoms of disease, the order of merit is as follows:—

[B.181 BP.52] [A.7834 A.791] [A.7261 M.U.8A]

Varieties that did not differ significantly are bracketed together. This experiment therefore confirms and supplements the experiment of 1946-47, in that M.U.8A consistently, under conditions of widely varying disease intensity, is more susceptible to *V.* wilt than BP.52 and B.181.

In the experiment analysed as a whole, B.181 is not shown to be significantly more resistant than BP.52. This is due to a tendency, under the most severe wilt conditions, for the proportion of visibly affected plants in B.181 to approach that in BP.52. In the 10 less severely affected blocks, as in the experiment of 1946-47, B.181 was affected in a significantly less proportion than BP. 52. A.7261, from a cross of M.U.8A and BP.52 back-crossed on to BP.52, seems to have none of the resistance of the BP.52 parent. The presence of some degree of resistance in A.791 (M.U.8A $\times$ Tidewater) and A.7834 (U.4 $\times$ Sea Island), was fore-shadowed by the demonstration of variable reaction to artificial inoculation in other progenies of the same crosses in 1947-48.

Yields in this experiment were lower than in the similar experiment on the same site in 1946-47, the severe incidence of wilt and the drought of December and early January probably both contributing to this result. Mean yield of seed cotton per plant in gms., and mean unadjusted wilt incidence up to 118 days from planting, are summarised for each of the 6 strains and hybrid progenies in the next table.

TABLE V.

		MU.8A	BP.52	B.181	A.7834	A.791	A.7261	Sig. diff.
Yield (mean)	...	40.6	33.6	46.9	23.8	31.0	32.1	3.28
% wilt (mean)	...	65.4	34.1	27.2	50.5	55.4	66.7	

In yield of seed cotton per plant, in descending order from left to right :

B.181 MU.8A | BP.52 A.7261 A.791 | A.7834

In the yield data of this variety trial considered together with those of the trial of 1946-47, two indications are prominent. Firstly, there has appeared an unexpectedly high yielding capacity in areas of relatively high wilt incidence, as compared with that in areas of lower incidence. The simplest explanation, for which there is some supporting evidence, is that some factor (or factors) leading to increased fertility has led also to increased wilt incidence, the effects on yield of increased fertility and increased wilt having tended to counterbalance one another.

Secondly, the yields of some of the susceptible strains (particularly MU.8A), under increasingly severe wilt incidence, have been maintained to a surprising degree as compared with those of resistant strains, especially when not only the relative proportion of affected plants, but also the less severe symptoms shown by affected plants in the resistant strains, are taken into consideration. Resistant strains under increasingly severe wilt incidence have failed to give the yield, over that of susceptible strains, that might be expected. On present evidence it may be suggested that the onset of wilt symptoms in any one plant has caused, by reduction of its competitive effect on its neighbours, compensatory increased growth and yield in the latter. Further, that the magnitude of this effect has varied from one strain to another, according to the severity of disease in individual plants and according to inherent strain characteristics.

BACTERIAL BLIGHT

In previous seasons, inoculation at Barberton of plants of varying genotypes in respect of resistance to angular leaf spot in the Sudan ($B_2B_2B_3B_3$, $B_2B_2b_3b_3$, $b_2b_2b_3b_3$, and unknown), by spraying with suspensions of *X.malvacearum*, has given disappointing results. In no instance were there demonstrated clear differences in susceptibility to angular leaf spot of the order of those observed in the Sudan. In no instance did the blackarm or bacterial boll rot phases of the disease develop to any appreciable extent, although in other fields on the Station the natural incidence of both of these phases was sporadically severe.

These results being thought possibly in part attributable to variations in host physiology arising from varying soil conditions, the present season's experiment was designed primarily to study the influence of varying fertilizer applications on the incidence of all phases of the disease.

Compost nil and at the rate of 10 short tons per acre, potash nil and at the rate of 400 lb. KCl. per acre, and superphosphate nil and at the rate of 500 lb. per acre, were applied in all combinations in 4-fold randomised replication to plots of 11 rows each of 37 hills at normal 3 ft. $\times$ 2 ft. spacing. The plots were later planted with U4/5143 (9 rows), the remaining two rows, in the middle of each plot, being planted with XA.129 (b_2b_2) and its resistant counterpart BAR. 11/2 (B_2B_2) in randomised order.

Forty-two days after planting, the plots that had received compost were given a top dressing of sodium nitrate at the rate of 100 lb. per acre.

On the 48th and 49th days from planting, the rows of BAR. 11/2 and XA. 129 in 2 of the 4 blocks chosen at random were sprayed with a suspension of *X.malvacearum* by means of knapsack sprayers, by the normal methods designed to minimise effects possibly arising from irregularities in the operators, machines, and times of application. The suspensions were prepared from cultures of a strain of *X.malvacearum* recently isolated from a blackarm lesion, at the rate of 4 petri dish cultures per $3\frac{1}{4}$ gallons water (the capacity of the sprayers).

On the 74th and 75th days from planting, i.e. 26 days after the first spraying, by which time sufficient new growth, free from infection, had developed to enable any results of the later spraying to be easily distinguishable from effects of the first spraying, the same rows were sprayed with similar suspensions in the same manner.

Weather data relevant to the two sprayings, for week A (the week preceding the 2nd day's spraying) and weeks B, C and D succeeding, were as follows :—

		Mean °F (Standard screen)		Mean hrs. sunshine.	Total rainfall (inches).
		Max.	Min.		
1st spraying.	Week A (23-29/12/48 incl.)	93.5	65.9	10.3	Trace on one day
	Week B	83.8	63.4	4.1	0.30
	Week C	92.1	64.4	8.4	0.53
	Week D	88.3	66.3	3.7	1.78
2nd spraying.	Week A (19-25/1/49 incl.)	82.1	68.3	2.6	2.72
	Week B	84.6	66.7	3.2	1.90
	Week C	79.6	61.7	5.0	0.67
	Week D	83.8	62.5	7.8	0.30

The first spraying was on 29th and 30th December ; December rainfall (1.81 in.) was the lowest, and mean standard screen maximum temperature the highest, recorded since records started in 1927, and mean standard screen minimum was very close to the long-term average. November rainfall after planting on 11th was only 1.03 in.

No symptoms were seen until 10th January, 12 days after the 1st day's spraying, when very minute angular leaf spot lesions were observed. This incubation period is even longer than those recorded

in previous seasons, and it was noted at this time that the leaves on which the lesions were seen appeared to have matured rather rapidly, having a well matured appearance of the under surfaces and a texture describable as rather leathery. No differences in incubation period were observed between fertilizer treatments or between the 2 strains.

Seven days later, the leaf spots being still of watersoaked appearance, notes were taken of the general incidence of angular leaf spot in all pairs of sub-plots in the sprayed blocks, in such a way that pre-knowledge of which was BAR.11/2, and which XA.129, was avoided. This examination clearly demonstrated that:—

- (a) BAR. 11/2 was consistently more severely affected than XA.129, in that more leaves were more severely attacked, with more crowded lesions ;
- (b) vein lesions, predominantly occurring in leaves younger than those severely affected by angular leaf spot, were more common in BAR. 11/2 than in XA. 129 ;
- (c) there were no appreciable differences in severity of attack between plots of varying fertilizer treatment (though it should be noted that any such differences would be less readily observable, owing to distances between the sprayed rows under the different treatments, than those between adjoining rows of the 2 strains) ;
- (d) there were no consistent or appreciable differences between the strains or between the treatments in size or appearance of individual leaf or vein lesions ;
- (e) plant-to-plant variations, within sub-plots, in respect of all the above were considerable.

Later observations confirmed the above conclusions. Counts of numbers of plants showing vein lesions, in all sprayed sub-plots, gave the following figures :

<i>Mean % of plants showing vein lesions.</i>				
<i>Treatment.</i>			<i>Strain.</i>	<i>%</i>
Nil	37		BAR 11/2	56
C	45		XA 129	29
P	45			
CP	48			
K	42			
CK	40			
PK	35			
CPK	49			

Differences between strains highly significant. $P < 0.01$.
Differences between treatments not significant.
Interaction strains x treatments not significant.

In no instance did leaf spots or vein lesions develop the characteristics of susceptibility as manifested in the Sudan.

The incubation period of angular leaf spot consequent upon the second spraying was again rather long, though not accurately determined. 17 days after the first day's spraying, individual lamina lesions were up to about 1 mm. diameter, angular and of watersoaked appearance, occasionally starting to dry out. Differences between the two strains, in respect of angular leaf spot lesions, were the reverse of those observed to have occurred after the first spraying, in that it

was judged that on average more leaves were more severely affected in XA. 129 than in BAR. 11/2. This difference was however much less strongly marked than that from the first spraying. No appreciable differences between fertilizer treatments, in severity of angular leaf spot, were observed.

Vein lesions occurred fairly commonly ; no differences between strains or between fertilizer treatments were on this occasion demonstrable.

Plant-to-plant variation in severity of attack, within sub-plots, was again considerable, particularly in respect of vein lesions ; occasional plants, in both strains, seemed to have a particularly high susceptibility to this form of attack.

At the end of March, 20 weeks after planting and 13 weeks after the first spraying, senescence was just beginning to appear in both BAR. 11/2 and XA. 129 in the nil and P plots, and in all plots the earliest bolls were starting to open. (Both of these strains were well behind U4/5143 in both these respects). By this time, all leaf heavily infected by angular leaf spot as a result of the sprayings had shed, and there remained in the sprayed rows of BAR. 11/2 and XA. 129 only sporadic vein blight and blackarm. The incidence of blackarm was very light, and mostly in the form of withering of the tips of branches, more conspicuous than damaging to the crop. Some boll rot was also present, but not to any serious extent. There were no striking differences between strains or between treatments in the incidence of either blackarm or boll rot, and it was evident that any such differences that there might have been could be evaluated only by detailed recording beyond the capacity of existing resources.

Throughout the course of this experiment, the incidence of all phases of the disease was virtually nil in all strains in the two unsprayed blocks, and very slight indeed in the U4/5143 rows in the two blocks in which BAR. 11/2 and XA. 129 were sprayed.

In yield of seed cotton, the response of both XA. 129 and BAR. 11/2 to the various fertilizer treatments was very similar to that of U4/5143 (see Table III). XA. 129 and BAR. 11/2 did not differ significantly one from the other in the two unsprayed blocks, yields per acre being respectively 1278 and 1238 lb. In the two sprayed blocks, XA. 129 significantly outyielded BAR. 11/2, at 1,388 lb. per acre, against 1,200 lb., $P < 0.01$. This may well be a reflection of the observed greater extent of leaf damage in BAR. 11/2 consequent upon the first spraying, although other possibilities, for example, a differential positional effect, cannot with certainty be excluded.

Summary of main results.—The main results of experiments and observations on bacterial disease caused by *X.malvacearum*, over the past three seasons at Barberton, may be summarised as follows.

Spray application of bacterial inoculum, under probably as wide a range of climatic conditions as is likely to occur at Barberton, has

consistently failed to demonstrate fully the clear difference between resistant and susceptible types, based on the criterion of development and nature of leaf lesions, that is shown in the Sudan. In 1947-48, a season of unusually frequent rains, cool cloudy weather, and lush vegetative growth, some difference was apparent, but was insufficiently wide and consistent for certain determination of the genotype (in respect of genes governing leaf reaction in the Sudan) of individual plants. In 1946-47 and 1948-49, susceptible types failed entirely to demonstrate susceptibility, their grading on Knight's scale being judged identical with that of resistant types, both being graded from 5 to 7.

In respect of general severity of leaf attack, spraying when the plants were seven weeks old in 1948-49 led to unmistakably more severe attack in BAR.11/2 (resistant in the Sudan on the criterion of development and nature of individual lesions) than in XA.129 (susceptible on this criterion in the Sudan), in that more leaves were more severely attacked, with greater frequency of both lamina and vein lesions. Later inoculations of the same plants led to an opposite effect in respect of lamina lesions, though to a less striking degree. In other seasons, no differences of this nature were seen, except that in 1947-48 MU.8A was relatively little affected as compared with all other strains then tested.

In all three seasons, the incidence of both blackarm and bacterial boll rot in spray-inoculated plots has been slight ; moreover, it has been less, sometimes very conspicuously less, than that naturally occurring in other fields on the Station, sometimes in the same strains as those used in the spraying experiments.

It is concluded therefore that Knight's foliage-spraying technique is inadequate under Barberton conditions for determination of the relative resistance of plants to damaging attack by *X.malvacearum*—the term "resistance" being here employed both in its broadest sense, and in the restricted sense implicit in Knight's method of determination.

The failure at Barberton to obtain demonstrations of susceptibility on Knight's criterion, in strains shown to be thus susceptible in the Sudan, is probably ascribable to climatic conditions : the combination of high atmospheric temperatures and high soil moisture generally accepted as necessary for full development of leaf lesions, and hence necessary for clear distinction between Knight's susceptible and resistant types, is at Barberton an uncommon occurrence.

It is therefore clear that under Barberton conditions—and this, to judge from recent reports from Experiment Stations in Uganda, Tanganyika and Nyasaland, would appear to apply in these areas also—new inoculation techniques and new criteria for judging resistance will be required in selection and breeding for resistance to *X.malvacearum*.

PROGRAMME FOR UGANDA.

After finally leaving Barberton at the beginning of October, 1949, I spent some four weeks in Uganda in observations on cotton diseases (mainly bacterial disease) and in discussions with my colleagues and with Messrs. Jameson and Thomas of the Department of Agriculture, to all of whom I am indebted not only for stimulating discussion but also for much kindly hospitality.

Clearly bacterial disease is an important factor limiting cotton production in Uganda, and the problem is one of much complexity. Resources are at present inadequate for study of all aspects of the disease, and work at Namulonge will at first be concentrated on epidemiology and on the development of techniques for evaluating inherent resistance to all phases of the disease under Uganda conditions. Studies on (for example) the physiology of parasitism and the nature of resistance, desirable though these may be, must for the time being be deferred.

My visit to Uganda was too early in the season to make personal assessment of the importance of *V.* wilt disease. Work on this disease will continue, mainly along the lines of varietal resistance and of factors influencing survival and carryover of infection.

ENTOMOLOGICAL AND PHYSIOLOGICAL SECTION.

BY

R. C. RAINEY.

CLIMATIC CHARACTERISTICS OF THE SOUTH AFRICAN COTTON-GROWING AREAS.

Considering South Africa as a whole, the areas in which cotton has been produced under boom conditions are delimited with fair accuracy by the March isotherm of 70°F., together (so far as rain-grown cotton is concerned) with the isohyet of 15 in. annual rainfall. Conditions over a considerable proportion of the areas so defined are however marginal for cotton, with respect both to rainfall and to pests. A mean annual rainfall of 20 inches or more appears necessary for continued commercial cotton production, parts of the Lebombo Flats and of the north-western Transvaal having been found unsatisfactory in this respect. Along the coastal belt, in Natal and adjoining territories, production is limited by stainers, *Dysdercus nigrofasciatus* Stal alone in the south and together with *D. fasciatus* Sign. and *D. intermedius* Dist. and red bollworm (*Diparopsis castanea* Hmps.) in the north—all with wild host-plants in this belt.

In the main South African cotton-growing areas, in the eastern Transvaal, Swaziland and northern Natal, cotton is grown most successfully in sheltered valleys, characterised by temperatures which are higher in summer and lower in winter (and by a lower rainfall)

than neighbouring areas at similar altitudes which are more exposed to maritime climatic influences. The altitude limit for cotton in this region rises progressively from 1,500–2,000 feet near the coast to 3,000–4,000 feet well inland, and appears to be primarily determined by summer temperatures, corresponding closely with the 72° isotherm of mean temperature for the quarter December–February. Neither mean annual temperature nor, in general, length of frost-free season appears to represent limiting factors in these areas.

With the exception of the lower Orange river (where cotton grows particularly well), the cotton-growing areas of South Africa (like those of Uganda and Tanganyika) are characterised by temperature regimes which are very much less extreme than those of the United States Cotton Belt. The higher temperatures at planting in the African areas are associated with more rapid germination than is usual in the U.S., while the relatively lower temperatures at the fruiting stage are associated with longer periods of boll development in the African crops.

Soil temperatures within the crop are greatly affected by variations in the amount of shade resulting from differences in plant development ; such differences in cover have been found associated with differences of more than 5°F. in the soil temperature even at a depth of two feet. MacDonald has suggested that such differences in soil temperature, resulting from varietal differences in density of cover, might be a factor in the “earliness” of dwarf strains, such as the U.4/4/2 derivatives 929 and 955, compared with the relative “lateness” of more bushy varieties such as A.2106.

Rainfall and yield.—In a preliminary investigation of the effects of rainfall fluctuations on crop production at Barberton, the yield figures recorded for two standard local strains (U.4/4-052 and its derivative 5143, which were in general cultivation during 1935–39 and 1939–47 respectively) in all variety trials on the diorite loam section of the Cotton Experiment Station, over the period 1934–49, have been examined in conjunction with the total rainfall recorded at the Station during successive 5-week periods before and after planting.

The results were at first sight somewhat startling. None of the variations in rainfall experienced *after* planting were found to have any significant effect upon yield—in contrast to e.g., maize ; the mean maize yields of the Mazoe district in Southern Rhodesia for example have been found to be very significantly correlated with the rainfall during the latter half of February and early March (Sellick, 1930). Both cotton strains however gave independently a very highly significant correlation between yield and the rainfall during the five weeks *prior* to planting. Still higher correlations were obtained by including still earlier rainfall ; totals over periods of 40, 50, 80, 120 and 160 days prior to planting were tried, and for both strains the highest correlation was given by the 80-day total, which for strain 052 during 1934–40 gave $r = 0.7265$ (D.F. 10 and P. 0.01), and for 5143 during 1936–49 gave $r = 0.7652$ (D.F. 17 and P. 0.001). This means that more than

half the variance of the yield values (which includes variance between fields as well as the effects of all other independent weather differences between seasons) is associated with this single factor.

These striking results are in fact consistent with a number of other observations at Barberton. The absence in the figures quoted above of any positive effect upon yield of additional rainfall after planting—despite the range of e.g., 12 inches to 36 inches in total rainfall between planting and picking—in contrast to the marked positive effect recorded for maize, is in agreement with the characteristic drought-resistance of the deep-rooted cotton crop once it is established. The very high correlation of yield with rainfall prior to planting may throw light on the well-established value of early as opposed to late ploughing (Heath, 1934, etc.); the former practice might be expected to reduce run-off losses. The correlation is consistent with the fact that much of the effect of different rotation crops and of fallow on following cotton yields at Barberton has been found to be associated with differences in the soil moisture left by the preceding treatment (Heath, 1934–35; Parnell & MacDonald, 1942). It is also in accordance with the marked effects upon cotton yields of the very early vicissitudes of the crop, demonstrated for example at Barberton by the marked adverse effect upon yield of planting large numbers of seeds per hill, even when combined with early thinning (MacDonald, Fielding & Ruston, 1939), and in the Sudan Gezira by marked correlations between very early vegetative development and final yield (Crowther, 1941).

After the correlation between yield and rainfall prior to planting had been demonstrated on the Barberton data, it was found that similar results had recently been obtained in the Sudan (Ireland, 1949), where a significant positive correlation was found between yield and the rainfall during the six weeks before sowing. Since this effect is thus exhibited by crops as diverse as those of the Sudan Gezira, where Egyptian cotton is grown under irrigation on a heavy clay soil, and of Barberton, where rain-grown Upland cotton is produced on a well-drained loam, it is tempting to suggest that it might apply in other cotton-growing areas also, though the mechanism of such an effect still awaits an explanation.

Rainfall abnormalities.—A recent publication of the South African Weather Bureau ("District Rainfall," Pretoria, 1949) has provided material for an objective examination of the fluctuations from season to season in the rainfall of the main South African cotton-growing region as a whole, in relation to some of the experiences of commercial growers during the last 25 years. The "unparalleled drought" of 1926–27 (Currie, Addison & Jeffreys, 1927) was in fact the most prolonged (though not the most intense) drought experienced by this region during the 40-year period for which adequate records are available; and "deluging rains....on the eve of picking time.... (which) almost ruined the (1924–25) crop" (Report of Cotton Industry Commission, Pretoria, 1929) represented in fact the wettest month on

record over this period. On the other hand "the exceedingly dry years of 1931-32 and 1932-33 (which) precipitated the annihilation of the industry" (Henning, 1948) were not in fact seasons of particularly low rainfall in the main cotton-growing region, though the latter season was the driest year on record in some other parts of South Africa.

Progressively declining rainfall is still sometimes suggested as a factor in the undoubted widespread advance of semi-desert conditions into formerly useful grazing areas of South Africa since the beginnings of European settlement. The publication already quoted provides an extensive analysis of the data now available on this subject; . . . "and in the light of the rainfall figures we are forced to conclude that there are no grounds for the belief that the precipitation in the Union has undergone a change during the past century." A second conclusion of general interest is . . . "that the quest for fixed cycles in our rainfall is a fascinating but futile pastime."

Wind effects.—High winds, associated with driving sand and dust, inflicted severe damage at the Barberton Cotton Station on crops at the seedling stage during 1931 and 1932. Wind-breaks were accordingly planted in 1933—belts of three or four rows of *Cassia siamea*, $7\frac{1}{2}$ feet apart, running north-south 150 yards apart, with east-west belts 400-600 yards apart. These trees, now 30 to 50 feet high, have helped considerably in this respect; their effect on the strength of the wind close to the soil surface is demonstrated by the evaporation figures. Annual totals of evaporation, in the centre of the area subsequently protected by the wind-breaks, ranged from 112 to 148 inches between 1927 and 1932, while the four seasons following the planting of the wind-breaks gave successive annual totals of 109 inches, 97 inches, 85 inches and 81 inches, the highest annual total subsequently recorded has been 96 inches, and the last ten years have given a mean annual total of 75 inches. Maximum and minimum temperatures, on the other hand, compared with corresponding records at a neighbouring station (Barberton Gaol) before and after the Cassias were planted, show that the effects of the latter on the local temperature regime have been slight.

Fallen leaves and miscellaneous plant debris at Barberton are quite commonly observed to be carried up by small whirlwinds and dust-devils to heights certainly of the order of a hundred feet and sometimes perhaps considerably more. In view of Wickens' recent demonstration of the importance of fallen leaf as a source of inoculum of *Verticillium* wilt, it is worth examining such evidence as is available to show how far such movements may extend.

Observations on the rate of fall of samples of typical leaf debris, collected beneath cotton in September, 1949, demonstrated terminal velocities (i.e., maximum falling speed, when gravitational acceleration has been balanced by air resistance) ranging from an average of about 400 ft./min. for a number of complete petioles to values of the order of 1,000 ft./min. for the most rapidly falling leaf material examined.

Concerning up-currents likely to be encountered above the immediate proximity of the surface, Brunt (1938) quotes an early sailplane flight in the Transvaal which demonstrated an up-current averaging nearly 1,000 ft./min. up to more than 10,000 feet above sea level; and subsequent gliding experience at a number of centres in the Transvaal has shown that such up-currents are very commonly to be found, particularly in dry, sunny weather. Vigorous up-currents are also experienced immediately ahead of cold fronts, and have been shown in one instance in the Transvaal to extend to more than 15,000 feet above sea level and to average at least 450 ft./min. for the whole of a 100-mile flight along the front (Rainey, 1947).

There can therefore be little doubt that leaf debris must occasionally reach heights of the order of tens of thousands of feet, and, with the terminal velocities observed, will sometimes be airborne for periods of the order of an hour at a time. During such periods it will of course be transported with respect to the ground with the horizontal wind velocity at the time. Strong winds in this area are predominantly southerly, often in the rear of cold fronts; gusts up to 58 m.p.h. were recorded behind the front already mentioned.

It would therefore appear that the Barberton valley may well receive plant debris from time to time from very considerable distances to the south. *Verticillium* wilt was known to occur at Magut at least five years before its first appearance in the Barberton area, a hundred miles to the north; the possibility of seed transmission has been disproved, as far as any negative can be; and other host-plants appear relatively unimportant (Wickens, 1948-49). Picturesque though the suggestion may seem, wind-borne inoculum from the south thus appears on present evidence to provide the most likely mechanism so far suggested to account for the original appearance of the disease at Barberton.

BOLL DEVELOPMENT OBSERVATIONS.

Pre-war work on boll development, briefly mentioned in previous Reports (1938-40) has been completed and published (Rainey, 1948). This work was undertaken primarily as a study of the changes in susceptibility to pests and diseases during boll development, but two points of more general interest may be mentioned here.

The first fortnight of boll development is characterised by extremely rapid growth, the dry weight of the ovules being approximately doubled every two days throughout this period. Growth at this rate might be expected to be very vulnerable to temporary interruptions in the supply of nutrients, and it is in fact during this stage that the boll is particularly liable to physiological shedding—which, even in a good crop, may account for more than half the total bolls set.

The cellulose of the mature lint and the oil and protein of the ripe seed are mainly laid down after the boll reaches full size (at 4-5 weeks under local conditions), about half way through its maturation period,

and are largely derived from materials entering the boll in the course of its subsequent development. Defoliation, natural or artificial, must therefore be regarded as still liable to affect yield even when it does not occur until after most of the bolls have attained full size.

RATOONING AND THE COMPULSORY CLOSE SEASON.

The extensive field survey work of the Corporation's entomological staff during the '30's provided a very substantial body of evidence of the striking effects of ratooning in fostering South African cotton pests. Ratooning is however still occasionally advocated, as in a recent article in the official journal "Farming in South Africa" (Henning, 1948). This particular article mentions objections to ratooning as encouraging insect pests, but regards them as perhaps having been overstressed, and quotes the Report of the 1927-28 South African Cotton Industry Commission as concluding that there is not sufficient proof to support the contention that insect pests are promoted by ratooning.

With the recent revival of cotton growing in the Union, steps were taken to make it possible to introduce a compulsory close season in terms of the Orchards and Cultivated Plants Cleansing Act of 1947; and a summary of the local evidence available on this point, together with a complete bibliography of the Corporation's entomological work in South Africa, has been prepared for publication as a Scientific Bulletin of the Union Department of Agriculture.

STAINERS AND WEATHER.

The temperature regime of the main South African cotton-growing areas often represents marginal conditions for stainer egg development, even during the growing season. Thus a substantial mortality of newly-laid eggs of *D. nigrofasciatus* has been found to result from exposure to temperatures of 93.5°F. or more for an hour, or of 58° or less for a 5-day period (Pearson, 1939); and, during April, 1939, soil temperatures at a depth of 1 inch in a well-grown crop of 5143 were not only above 93.5° for a total of 14 hours but also below 58° for 38 hours. Thus the temperature regime of this month—the time of year of the main stainer attack on cotton—recorded at a potential egg-laying site at which crop cover was probably considerably better than average, probably would have produced an appreciable mortality of *D. nigrofasciatus* eggs from cold as well as a heavy one from heat.

The less extreme temperatures of the adjacent coastal belt, as compared with those of the main cotton-growing areas, may thus be a factor in the heavier stainer attack experienced nearer the coast. The winter breeding which is known to occur in the coastal belt (Pearson, 1935) is tentatively suggested as a potential source of the stainers which appear, somewhat mysteriously (Pearson, 1938-39), at the beginning of the season in the main cotton-growing areas further

inland. It is suggested that the vigorous convection currents and powerful sea breezes characteristic of this region and season may contribute to such a movement of stainer populations.

STAINER PARASITES.

Pre-war observations on the Tachinid flies parasitising stainers in South Africa have been analysed and published (Rainey, 1947). Up to 35% of adult *D. nigrofasciatus* from a heavily infested late cotton crop at Barberton were found to be parasitised by Tachinid larvæ at the end of the season. The predominant species of parasite was *Alophora nasalis* Bezzi; *Bogosiella fasciata* F., the commonest species in Uganda, was present in smaller numbers, and appears to be generally more common in regions of higher rainfall.

These observations showed higher levels of parasitism than had previously been recorded either locally or in Uganda. However, the development of the Tachinid larvæ within the stainer was a protracted process under local winter conditions, the larval period of *A. nasalis* being of the order of 2-3 months, and parasitised stainers were correspondingly long-lived—certain parasitised individuals even outlived more than half their unparasitised contemporaries! So far there is in fact no local evidence of any serious effects on stainer numbers attributable to the Tachinids, whose economic value in this areas, as in Nigeria, appears to be correspondingly slight.

COTTON IN ETHIOPIA AND THE SOMALILANDS.

Information on cotton-growing in these territories, collected incidentally during 1941, 1947 and 1948, has been published in the "Review" (Rainey, 1949).

REFERENCES.

- Brunt, D. (1938), *Nature*, **141**, 712.
 Crowther, F. (1941), *Ann. Bot.* v., 509.
 Currie, Addison & Jeffreys (1927) (report to ECGC on African tour).
 Heath, O. V. S. (1934), etc., *ECGC Repts. Exp. Stas.*
 Henning, L. J. (1948), *Farming in S.A.*, Aug.
 Ireland, — (1949), Discussion of agricultural meteorology. *Quart. J. R. Met. Soc.*
 MacDonald, D., Fielding, W. L. & Ruston, D. F. (1939), *J. Agric. Sci.*, **29**, 418.
 Parnell, F. R. & MacDonald, D. (1942), *Reps. Exp. Stas.*
 Pearson, E. O. (1935 *et seq.*) *Reps. Exp. Stas.*
 Rainey, R. C. (1947) *Bull. ent. Res.*, **38**, 305.
 " " " *Quart. J. R. Met. Soc.*, **73**, 437.
 " " (1948), *Ann. appl. Biol.*, March.
 " " (1949), *E.C.G. Rev.*, **26**, 186.
 Sellick, N. P. (1930), *Rhod. Agric. J.*, **27**, 962.
 Wickens, G. M. (1948-50), *Reps. Exp. Stas.*

[Included by courtesy of the Uganda Government.]

UGANDA.

REPORT OF THE SENIOR BOTANIST.

BY

J. D. JAMESON.

The studies of which this report is a preliminary account are being prepared for publication in greater detail elsewhere.

THE COTTON CROP IN RELATION TO CLIMATE AND DISEASE.

Introduction.

The cotton crop of 1940-41 greatly exceeded every estimate, and no obvious reason could be given at the time for its success. In January, 1942, an informal correspondence passed between Mr. T. R. Hayes and myself, as the result of which I undertook a general survey of the cotton crop in relation to climate and disease. In the early 1930's the British East African Meteorological Service greatly increased the number of rainfall recording stations, and as averages of ten years or more presented a consistent pattern of rainfall throughout Uganda, it was possible to study this aspect of the problem immediately. Statistics of cotton acreage and production were also put on a reasonably sure footing in the early 1930's, but it was not until 1945, when the records of at least 15 seasons were available, that it was found possible to build up a useful set of relationships. This study has proceeded up to the present time, and it is now possible to start putting certain hypotheses to the test. But as existing staffing arrangements will not endure indefinitely I have been persuaded to write a summary of my conclusions, although I am fully aware of their lack of completeness, and of how much depends upon the results of confirmatory tests.

The Pattern of Rainfall.

The year begins with a hot dry season in January and February. Then follows a period of mounting instability, with increasing rainfall, until the arrival of the inter-tropical front from the south in April, which causes the main or "first" rains in April and May. Then follows rather abruptly the cool dry season in June and July, which is much more marked in the south. The first six months of the year yield from 20 to 25 inches of rain throughout the greater part of Uganda. More than 25 inches fall along the shores of Lake Victoria, and less than 20 inches in the immediate vicinity of Lake Kyoga. The distribution is also somewhat later in time as one goes north.

The rainfall in the second half of the year is much more complex. Instability is resumed in August, but more markedly in the north and north-west, where the heaviest rains of the year may occur. After September there tends to be a lull, until the inter-tropical front returns from the north in November. But the November rains are very uncertain, and usually they only make a considerable contribution when they reach the neighbourhood of Lake Victoria. In December the hot dry season begins.

The "second" rains, as they are misleadingly called, really consist of two portions. The first portion in August and September is a resumption of the first rains, and is most marked in the north. The second portion in November, the true second rains, is most marked in the south. Consequently in the second half of the year there is an appearance of a much earlier distribution as one goes north. In all, the second six months of the year yield from 20 to 25 inches of rain near Lake Victoria and in the vicinity of Lake Kyoga, and 25 to 30 inches elsewhere, rising to over 30 inches in the north-west.

The Cotton Crop and Rainfall.

Cotton statistics consist of an estimate of acreage, a fairly accurate return of the crop, and a figure for yield per acre calculated from the two. Consequently any imperfections in the estimate of acreage are reflected inversely in the yield.

The first step was to relate the statistics for 15 years or more, drawn from each of the principal cotton growing districts, to the rainfall in each month of the year in turn, to see which months were the most critical for the success of the crop. For this purpose the rainfall throughout the Lake Kyoga drainage basin was employed, as this embraces nearly all the cotton in Uganda, and it was expressed as percentages of the appropriate monthly averages. Ideally the rainfall for each district should have been compiled separately. But the method employed was a great saving in labour, and also wet or dry periods tend to be general in relation to local expectation.

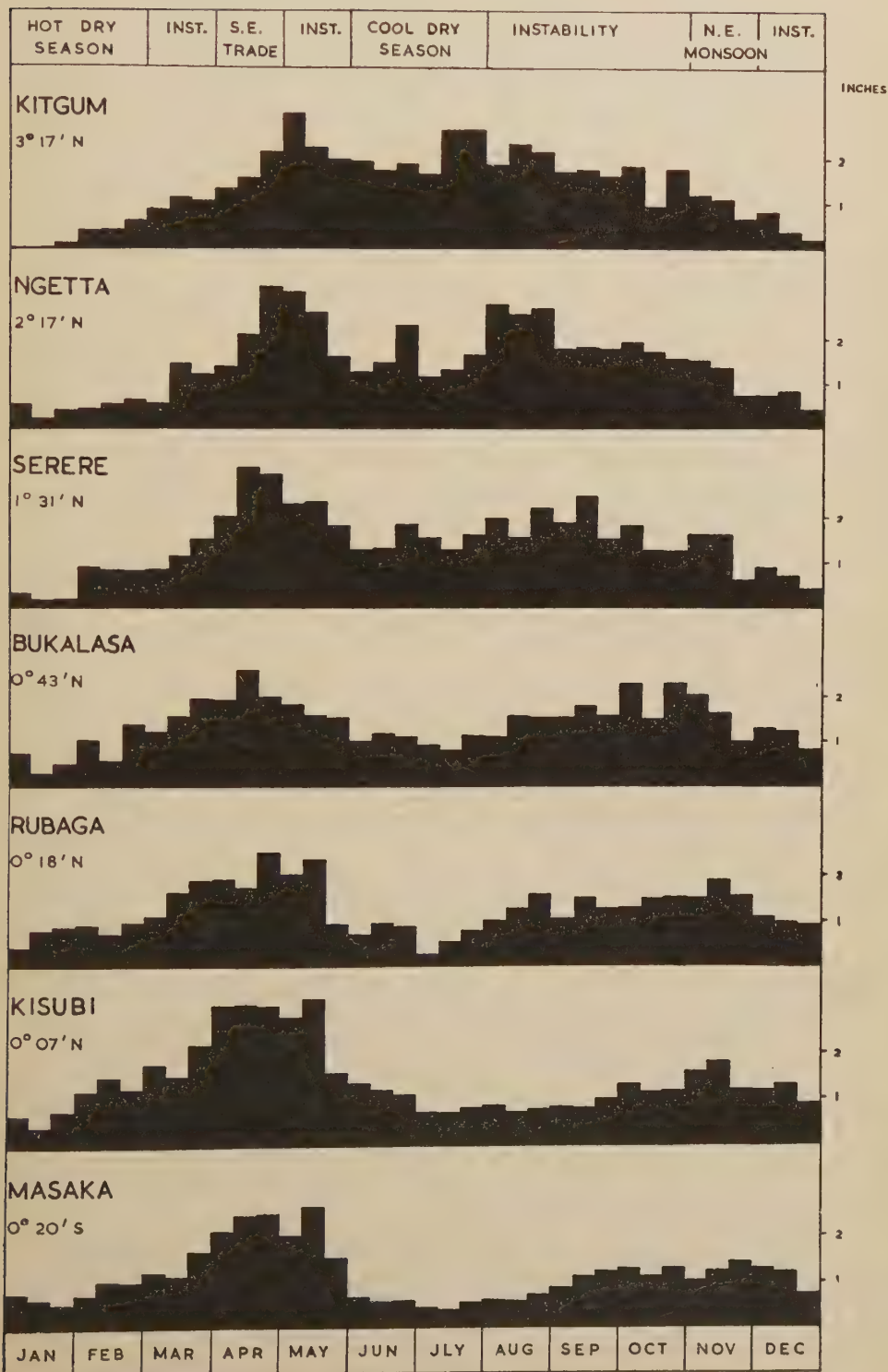
This survey revealed four critical periods :

- (a) February gives a strong positive relation between rainfall and the yield of the crop in the subsequent season, a fact known some time ago to Hosking*.
- (b) July gives a positive relation, which is largely confined to the south.
- (c) August gives an inverse relation, which is most marked in the north and east.
- (d) October gives a positive relation.

The first and third of these periods, the former having critical importance, are discussed at length in a later section.

* Hansford, C. G. & Hosking, H. R. (1938), *Empire Cotton Growing Review*, 15, 7.

UGANDA RAINFALL NORTH TO SOUTH



July Rainfall.

July is the peak planting month. The relation between rainfall and yield is not important in the north, but its importance increases as one goes south. At Serere (Lat. $1^{\circ}31'N.$) June and July each yield an average of over four inches of rain, and establishment is not normally a serious problem. At Bukalasa (Lat. $0^{\circ}43'N.$) this figure drops to three inches, at Kawanda (Lat. $0^{\circ}25'N.$) to two inches, and at Masaka (Lat. $0^{\circ}20'S.$) to about one and a half. These facts suggest the tenable hypothesis that the rainfall becomes increasingly critical for establishment towards the south, and also explain why the crop is planted progressively earlier from Bukalasa to Masaka.

October Rainfall.

October is the flowering period, and the bulk of the crop is set in October and November. It is therefore understandable that yield is related to rainfall in October.

Sowing Date.

Before considering the effect of rainfall in February and August it is necessary to make a considerable digression into general relationships between sowing date, acreage and yield, largely in order to dispose of some prevalent fallacies. The crop is sown in June, July and August, together with a small proportion in May and September. A mean sowing date for any given district or year is easily obtained from the monthly planting returns, and is largely independent of errors in estimation.

It is well known that an early sown crop tends to be a large one. But the apparent and widely held conclusion that this is because earlier sowings yield more is erroneous. Early sowing results in a larger acreage, presumably because there is more time to prepare and sow additional plots. This result is most marked and applies to the whole country, save for a small area in central Buganda (Bulemezi-Kyadondo).

Early sowing does result in a larger yield in three areas: Masaka, Usuku county of Teso district, and Bulemezi-Kyadondo. In Masaka the need to establish the crop before the cool dry season has already been noted, and the second rains are so feeble that the advantage of early sowing is understandable. In Usuku the rainfall in November is negligible and the hot dry season starts in October, so that early sowing is imperative. Bulemezi-Kyadondo is at first sight a most improbable area for finding this effect. My explanation is that here late planting* does give some economic return. Consequently in a delayed season the full acreage is completed in Bulemezi-Kyadondo, as already noted, with some loss of yield, whereas in other districts the people do not resort to late planting in a delayed season; the acreage is reduced, and the yield remains the same.

* In this context the term "late planting" is strictly reserved for planting which is *too* late, so that yields are materially reduced. Generally speaking it embraces all planting in August and September.

This implies that over the range of sowings from May to July yield varies only within narrow limits, an implication which conflicts with the result of innumerable sowing date trials, which have shown most consistently that yield descends steeply over this range. Several workers have pointed out that when a sowing date test is conducted in small, replicated and contiguous plots the cross-interference by diseases and pests must necessarily favour the first sowings and prejudice the later ones. Despite some recent attempts to test this criticism the point remains undecided one way or the other. But district variety trials, of which there have been a great number, sown on various dates according to the fortunes of place and season, have tended to give the highest yields when planted rather later than mid-way in this range, namely in late June or early July. I am therefore inclined to believe that the general relationships which I have described are genuine.

February Rainfall.

Those who are aware of the very strong relation between rainfall in February and the yield of the subsequent crop have been inclined to explain it as due to a general advancement of all agricultural operations, leading to earlier sowing of cotton. It is necessary to reject this explanation as a principal effect, for two reasons. Firstly, as we have seen, the effect of sowing cotton earlier would appear in acreage and not in yield; and rain in February does not lead to a bigger acreage. Secondly, the records show quite clearly that, although rain in February advances the millet crop, and other food crops grown in the first rains, there is no relation between rain in February and the mean sowing date of cotton, which fluctuates independently according to the distribution of rainfall at the time of planting.

Consequently it is necessary to look for some other explanation, and one supported by observed facts is found in connexion with the foremost disease of cotton in Uganda, namely blackarm (*Xanthomonas malvacearum*). The records from district variety trials show quite clearly that when the rainfall in the first quarter of the year is above average the incidence of blackarm is much reduced. Furthermore, blackarm is least severe in those parts of Uganda which normally receive three inches of rain or more in February.

August Rainfall.

The inverse relation between yield and rainfall in August, when the young crop is actively growing, is at first sight strange. But here again the records from district variety trials clearly show that when the rainfall in the third quarter of the year is above average the incidence of blackarm is much increased. And blackarm is most severe in districts which normally receive five inches of rain or more in August.

Blackarm in Busoga.

These relationships are seen to perfection in Busoga, where the rainfall in both February and August fluctuates about a critical figure.

The two effects interact to a considerable extent, and in two ways. Firstly rainfall in February and rainfall in August tend to be related inversely. ($r = -0.58$, P less than 0.02). Secondly it is only when rain above average in February is followed by rain below average in August that a really big benefit emerges. In the period 1934-47 this happened in the planting seasons of 1935, 1936, 1937 and 1940, the last of these being the season which provoked this study. In Busoga district the yield in these years was more than 50% greater than that obtained in years when the combination of rainfall in February and August was less favourable. In Teso district the yield in these years was more than doubled.

Hypothesis.

There is general agreement that heavy rainfall in August favours the spread of secondary blackarm infection in the young growing crop. As regards rainfall in February my hypothesis is that a close season which is wet from the outset favours the rotting down in the field of the infected debris which inevitably drops from the previous crop*. But in the majority of years the close season may be dry enough to permit an appreciable carry-over of infected debris. When the carry-over of the disease in debris is large, secondary spread produces an epidemic in almost any weather likely to occur. When it is small the rain in August is critical for deciding whether secondary spread reaches epidemic proportions or not. It is also possible that when the calendar year opens with an unusual amount of rain, and the seed is ginned and stored rather damp, infection on the seed does not endure so long.

Experimental Programme.

The whole cotton programme at Serere has been re-cast this year to investigate means of reducing the incidence of blackarm in the crop. With the assistance of Messrs. Imperial Chemical Industries Ltd. an attempt is to be made to eliminate, or drastically reduce, the carry-over of the disease in the seed by physical and chemical means. An attempt is also to be made to test the hypothesis of carry-over in debris (with and without seed treatment) by growing cotton on freshly opened land, retaining half the sub-plots as controls, and placing on the other half debris collected from elsewhere.

Should this experiment confirm the hypothesis†, it would be well to encourage any agricultural practice, or any point of management, likely to rid old cotton fields of debris. Also a further most cogent reason will have been added for maintaining the longest close season possible. Since the first rains are often delayed an extension of the close season at its latter end would be more valuable, and our plant breeding programme is already directed towards the selection of quick maturing varieties which would make the present earliest plantings unnecessary.

* Massey, R.E. (1934), Rept. E.C.G.C. Conf., 175. Weindling, R. (1948), U.S.D.A. Tech. Bull. No. 956. Padwick, G. Watts (1948), personal communication, 28.12.1948.

† This experiment has now given preliminary confirmation.

THE RESISTANCE OF COTTON TO BLACKARM UNDER RAINFALL.

Angular Leaf Spot.

The Uganda breeding stocks were first sorted for the resistance gene B_2 according to the technique of Knight & Clouston*, at Serere in the planting seasons of 1942 and 1943. In 1942 the material was planted at the end of June, conditions for grading were excellent, and phenotypically resistant plants were selected without difficulty. In 1943 the material was planted a good deal earlier, and the development of angular leaf spot was not so satisfactory. Nevertheless genetically resistant progenies were selected with reasonable success.

Parallel work at Kawanda met with no certain success, and Dr. Knight was invited to visit Uganda in August, 1946. He came to the conclusion that the cool cloudy weather which occurs at Kawanda at that time of year was not suitable for the work. As a result of his recommendations all work on resistance to blackarm was concentrated at Serere, and planting delayed until July, so as to take advantage of the rainfall and rise in temperature which normally occur at Serere in the months of August and September.

The whole range of relevant material was planted at Serere on 5th July, 1948, and sprayed with blackarm suspension on 17th August. Heavy evening rain fell repeatedly after bright sunny days, and although it was fully three weeks before typical symptoms of angular leaf spot developed, the progress of the disease was then exceedingly severe. I did all the selection in person during the second week of September.

The symptoms were much too severe to permit the use of Knight's grading system. In resistant material innumerable pale brown dry spots, having the appearance of brown paper, covered a high proportion of the leaf area. The leaf margins curled upwards, so that each sprayed leaf took on the form of a crumpled ball of paper. Eventually a violent storm stripped most of these leaves off the plants.

But it was soon apparent that there were other means of distinguishing between resistant and susceptible material. In resistant material each necrotic spot or area was surrounded by a greenish-yellow halo, as described by Weindling (1948), whose paper was unfortunately not received here until July, 1949. Under magnification the chloroplasts appeared to have degenerated in these halos, and the cytoplasmic contents had become diffuse. This led us (working with Mr. D. G. Thomas) to postulate hypersensitivity, an hypothesis which is rejected however by Weindling.

In susceptible material the necrotic areas were larger, watery and black, and were hard up against normal green tissue. The necrotic areas also appeared to spread readily across the veins, giving the vessels in the vascular tissue a bright orange appearance under magnification. Where this occurred droplets of bright red anthocyanin

* Knight, R. L. & Clouston, T. W. (1939), *J. Genet.*, **38**, 133.

pigmentation appeared in the cuticles on the upper and under surfaces of the lamina (but more markedly on the upper surface), on the distal side of the affected point on the vein. This suggested partial or complete interruption of translocation.

Where this interruption occurred at some point on the leaf lamina, sectorial pigmentation developed on the distal side. But where it occurred at the junction between lamina and petiole—the danger spot which tends to hold droplets of rain or dew—pigmentation developed over the whole lamina. This leaf-reddening is characteristic of the Sunflower-Allen-Floradora stocks in Uganda (which are susceptible to blackarm), and has been known for a long time as physiological leaf-reddening. The local commercial crop was immediately examined in the field, and it was found that *premature* leaf-reddening in the absence of jassid attack was almost invariably associated with ringing of the petiole at this danger spot.

Returning to the breeding stocks, the material was then sorted on a basis of yellow halo versus premature leaf-reddening, and ratios in accordance with B_2 expectation were obtained. It appears therefore that we may have a new basis for the selection of B_2 resistant plants, given the right conditions after spraying under rainfall.

The Stem Lesion.

The work founded by Hansford from 1930 onwards depended on a count of stem lesions. This was successfully exploited by Hosking in his breeding work, although the lesion count was not independent of plant size and therefore did not always bear an inverse relation to yield. By reducing the lesion count to a plus or minus observation on the main-stem only, I have now established a criterion which is independent of plant size, and which bears a strong inverse relation to yield. This is important, since it is the stem lesion (and boll lesion) which damages the plant, and reduces yield, and not the preliminary symptom of angular leaf spot.

Using this criterion I find not two levels of resistance, corresponding to the presence and absence of B_2 , but three levels. The lowest level (46% of the population free in a trial at Kawanda in 1948) corresponds to the absence of B_2 . The middle level (58% in this trial) corresponds to the presence of B_2 . But there is also a much higher level (82%), which indicates the presence of some other factor or factors besides B_2 . (The respective yields in this trial were 466, 534 and 650 lb. per acre.) Furthermore the middle level is attained or even exceeded by certain varieties which are believed not to contain B_2 , which suggests that this other factor, or yet another, is operating independently of B_2 . This technique is still imperfect, but these observations have now been repeated often enough to suggest that they are genuine. It also begins to clarify the position of the variety B.181, which contains B_2 , but has always been recognised as "super-resistant."

Experimental Programme.

It has already been said that the new programme at Serere includes work on the physical and chemical treatment of seed against blackarm. It will also include work on the inoculation of seed with blackarm, because the perfection of the main-stem lesion criterion not only demands that all the seed planted shall be of equal status, but also that it shall be heavily infected. The best time to exploit this criterion for resistance is about two months after planting, when infection of the main stem may cripple a susceptible plant, often killing the terminal growing point entirely. To achieve the right conditions it might be possible to infect the field with trash, or place a suspension of the bacterium on the young growing seedling. But since some uniform treatment of the seed is necessary in any case the inoculation of the seed naturally suggests itself.

It also follows that the programme of breeding for resistance, whilst adopting B_2 (and later maybe other genes) as a minimum standard, will in future return to this modified method based on the stem lesion. And since the publication of Weindling's paper it will also pay attention to the boll lesion.

THE RESPONSE OF THE COTTON PLANT TO DAMAGE.

Structure of the Plant.

In the type of cotton plant which is grown in Uganda each node on the main stem contains up to three potential buds. These buds may give rise, either to monopodial branches which behave in all respects like the main stem itself, or to sympodial branches on which the flowers are borne.

Starting from the cotyledonary node the first two or three nodes above it normally produce a single abortive monopodium each, though this abortive process may continue still higher if the crop is not thinned or not weeded. The next two or three nodes produce a single strong-growing monopodium each. These monopodia replicate the main stem, so that their suppression by lack of thinning or weeding, or by disease, is a serious matter. Above this level, starting from the sixth or seventh node above the cotyledons, a sympodium (normally one only) is produced at each successive node throughout the remainder of the plant's life. The basal monopodia produce secondary sympodia in a like manner.

If a sympodium is damaged another bud may develop and a monopodium is produced alongside. If this is also damaged, then a third bud may develop and produce a second sympodium. Alternatively if a sympodium is arrested at some point along its length, another bud may continue it as a monopodium, which in turn produces secondary sympodial branches. And if this is damaged, a third bud may replace it with a second sympodium. The usual rule is that if any branch is arrested it may be replaced by an alternative branch of

the other kind ; or it may be continued by a subsidiary branch of the other kind ; or the replacement may be made in both these ways.

Naturally the ability of the plant to build a new framework after severe damage depends upon the rainfall, the fertility of the soil, and the variety.

Damage.

Blackarm first appears on the cotyledons or young leaves as angular leaf spot, whence it may travel by the petiole to the main stem or branch. Subsequently it may invade stems, branches and bolls directly. In seedlings it may invade the main stem from the cotyledons and kill the terminal growing point. When this happens the plant is crippled, and though it does not usually die it is practically worthless as a contributor to yield. Alternatively the basal monopodia in the seedling may be killed, in which event the loss of yield is proportional to the number killed, as it is when these branches are suppressed by lack of thinning or weeding.

More normally blackarm reaches epidemic proportions later in the life of the plant, and does its greatest damage by arresting the extension of the sympodial branches, which die back and give rise to the characteristic appearance from which the name "blackarm" is derived. As these are the fruiting branches the loss of yield is immediate and direct.

Taylor* has described how the capsid bug, *Lygus vosseleri*, does its principal damage to the cotton plant with a similar result, namely by arresting the extension of the sympodial branches, the flower buds being shed.

It will be seen therefore that the arrest of sympodial extension is characteristic of much of the damage done to cotton plants in Uganda. The plant is "waisted," and grows tall and columnar, until the weight of the top crop bends it over. It is worth emphasising that towards the end of the season, if dry weather has checked blackarm necrosis, the cause of damage must be diagnosed with great caution. After severe blackarm attack a crop of columnar plants, carrying a crown of "shot-holed" leaves of no consequence, is easily accused of severe *Lygus* attack.

Semi-cluster Habit.

The American Upland varieties of cotton grown in Uganda are nearly all derived from Sunflower-Allen-Floradora stock, in which semi-cluster habit is inherent. Semi-cluster habit in Uganda comprises three characteristics :

- (a) rather numerous and very strongly developed basal monopodia
- (b) relatively short sympodia, ranging from six flowering points near the base of the plant down to two or one at the crown, with a long first internode and subsequent very short ones
- (c) very free development of dormant buds.

* Taylor, T. H. C. (1945), *Bull. Ent. Res.*, **36**, 121.

It is not difficult to see why this type of cotton plant came to be preferred at a very early date. If sympodial extension is liable to be arrested, it is more important that the sympodia shall be numerous than that they shall be capable of attaining length. Therefore the replication of the main stem by basal monopodial branches is an advantage, since the number of sympodia initiated is in proportion to the number of upright stems. From this follows the important corollary that the thinning and weeding of the seedling crop, which permit the free formation of basal monopodia, must not be neglected. It is also obvious that the inherent shortness of the sympodia is no disadvantage, and that the development of dormant buds to build a new framework when the first is impaired is a very positive advantage.

The proof of this was obtained fortuitously at Serere and Kawanda in 1945. The gene R^1 had been transferred to the variety BP.50, and the resultant type was growing at both places. R^1 not only confers a red colour on the plant body, but it also suppresses cluster habit*. The plants at Serere were severely damaged. The basal monopodia were few and weak. The plants had made no new framework, and had set very little crop. Their only response was to grow 8 ft. high. The plants at Kawanda had escaped damage. They were of normal height and pyramidal in shape, with sympodia extended to eight or nine flowering points, and a big crop.

Recovery from Damage.

It frequently happens that the type of damage described does not persist after the initial growing period, and that the long season permits a measure of recovery. Therefore the inherent ability of the plant to recover is important.

Varietal resistance is one approach to the blackarm problem, but this is only a partial remedy, and appreciable damage may still occur. Therefore it is possible for a resistant variety, which lacks the ability to recover, to yield less than a variety which is not so resistant.

The variety B.181 is known to behave anomalously in this respect. It produces a large number of small bolls and responds to high fertility†. Conversely it fails under conditions of low fertility, or when exposed to severe damage, despite the fact that it is resistant to blackarm. Therefore it is important to check blackarm resistant varieties, to see that their resistance is reflected in yield.

By contrast the variety BP.50, which is also resistant to blackarm, makes an excellent recovery from this type of damage, whatever the cause. This explains why its yield record is notable for being consistent, at different places and in different seasons.

* Harland, S. C. (1934), *Trop. Agric.*, **11**, 316.

† Manning, H. L. (1949), *Ann. Rept. Dept. Agric. Uganda*, 1946-47, II, 6.

Experimental Programme.

Having found that the variety BP.50 is satisfactory for these purposes, no special programme is in progress beyond the ordinary re-selection which is being done at Bukalasa.

ACKNOWLEDGMENT.

I am indebted to the Senior Entomologist, Mr. W. V. Harris, for discussion of the resemblances between recovery from blackarm and recovery from *Lygus* attack. I am also indebted to Mr. E. O. Pearson of the Empire Cotton Growing Corporation for much discussion in the past on the subject of cluster habit, without implying however that our views necessarily coincide in all respects. Finally I have to thank Dr. J. B. Hutchinson of the Empire Cotton Growing Corporation for reading the draft, and for suggesting some amendments to the wording of it.

COTTON EXPERIMENT STATION, KAWANDA.

B.P.52 BREEDING WORK, 1948-49.

BY

H. L. MANNING,

E. C. G. C. and Uganda Government.

INTRODUCTION.

The writer is indebted to Mr. D. G. Thomas who carried out the planting programme according to plans drawn up at the end of the previous season. All subsequent observations were conducted by the writer on return from leave.

SUMMARY.

One of the important objectives of the work conducted over the past two seasons was to assess the likelihood of yield improvement in the BP.52 stock. Detailed investigations—particularly during the past season—have shown that genetic variability is still high both for primary yield characters and for some morphological characters likely to be of value. It follows that with an efficient system of selection, real genetic advances may be expected.

The discriminant function or selection index technique is probably the most efficient method of selection. Accumulated data are now available, so that selections for 1949-50 were made by this method. The technique offers the real advantage of basing selection on the average performance of the largest possible number of progenies, and chance effects due to environmental causes are minimized.

Forty-eight progenies selected on their behaviour during the previous season were compared with the standard BP.52 modal bulk, and averaged about 5% greater yield than the control. This season 48 single plant selections from the 12 best strains—as indicated by the discriminant function—will be used as progenies for the 1949-50 breeding plot. The report shows that the further genetic advance in yield should be 12 to 15% for the average of all progenies over the control.

The provision of a uniform nucleus of BP.52 has been discussed in the previous report. The aim of this aspect of the work, unlike that in the progeny row breeding, is to reduce variability. During the past two seasons about 500 plants were examined for the characters lint per seed, seed weight and mean maximum lint length. All plants outside a specified range for each of these characters were discarded from the frequency arrays. The effect of the reduction of genetic variability is to produce a bulk with a larger percentage of plants near the average or modal value for each of the three characters. A similar bulk, though from fewer plants, was made with BC.66. This is a promising line with a proportion of plants showing resistance to *Xanthomonas malvacearum*.

During the season information was accumulated on characters other than those directly affecting yield. There is some evidence that earlier maturing strains may be evolved from BP.52. Much of this "earliness" is due to differences in time of ripening after flowering. At least part of the main stem elongation—so typical of BP.52 in Uganda—may be attributed to genetic causes, though it is of course exaggerated by early bud shedding. Information relating to the percentage of plants with one or more severe blackarm lesions suggests that there is considerable genetic variability in the BP.52 lines now being grown. Resistance was not, however, closely related to yield in the progeny row test.

Additional data are available to confirm that the optimum sowing date for the Kawanda area, which is typical of much of the south-west of Buganda, is about the middle of June.

METEOROLOGY.

Although the total annual rainfall is about 40 inches, it is distributed in two well marked seasons, which must be considered separately in relation to the crops which they carry. Monthly totals

for 1948, and means for the previous 12 year period, are given in Table 1. Numbers of rainy days are given in parentheses.

TABLE 1.
SUMMARY OF RAINFALL DATA—KAWANDA (IN INCHES).
RAIN DAYS IN PARENTHESES.

Month.	1948.	Mean of 12 years.
January ...	1.29 (8)	1.81 (7.7)
February ...	2.95 (6)	2.55 (8.1)
March ...	2.28 (12)	4.01 (12.7)
April ...	4.75 (13)	5.98 (16.2)
May ...	3.28 (15)	5.56 (16.8)
June ...	2.06 (14)	2.36 (9.6)
July ...	1.15 (12)	2.04 (8.1)
August ...	4.08 (11)	3.54 (11.7)
September ...	8.35 (17)	4.20 (13.4)
October ...	4.63 (18)	3.82 (13.3)
November ...	3.62 (11)	4.43 (14.2)
December ...	2.75 (8)	2.81 (8.9)
	41.19 (145)	43.11 (140.7)

Arguments have been presented in previous reports for the belief that rainfall may be marginal for crop development in one or both rainy seasons, even though there may be 40–45 inches over the whole year. The first rainy season is usually more reliable than the second, though the inadequacy of rainfall for the first in 1948 is evident from Table 1. Existing Uganda cotton varieties require some 7 to 8 months for satisfactory growth and maturity. It follows that when grown in the second rainy season they are subject to two risks—that the rainfall may be limited to 20 inches or less, and that the growing period may not exceed six months (August to January). Even with the exceptionally favourable conditions of 1948 (nearly 25 inches of rain during the second rainy season) yield levels were higher for the late May and early June sown cotton than for sowings in August and September.

GENETICS AND BREEDING.

(a) *Replicated Progeny Rows.*

The programme—now in its second year—was designed to assess the genetic variability of yield and morphological characters of existing strains of BP.52, many of which have been maintained by bulking self-fertilized seed from single plants. Assessment of the heterozygosity of current stocks could not therefore be attempted until performances were available from progenies descended from the same plant. Selections made on behaviour in the previous season led to a small but appreciable increase over the standard variety. This standard was a random sample of the BP.52 modal bulk described in the previous report.

A 7 × 7 lattice square with 4 replications was chosen to accommodate 49 progenies, and was planted on June 10th, 1948. The plots had 2 rows, each containing 10 plants at a spacing 3 feet × 2 feet. Later, 2 plants from each plot were selected for plant habit. Each was self-

fertilized. Data were adjusted for rows and columns where the efficiency compared to a randomized complete block lay-out exceeded 110%. Estimates of genetic variances and covariances were derived from these adjusted data analysed as complete block designs.

The 49 progenies consisted of 41 BP.52, 4 BAR strains of the Uganda type from the Sudan and one each of the standard varieties B.181, BP.50, N.17 and Buganda Local. The 41 BP.52 progenies were made up as follows:—21 progenies from 5 strains of the 5 original lines; 17 progenies from 8 strains of 8 of the new BP.52 lines; and finally representatives of the three BP.52 groups, modal bulk, BC.66 and the previous bulk BP.52 B.

Detailed studies were conducted on morphological and seed cotton characters during the season. Some data for the former are summarized in Table 2.

TABLE 2.
SUMMARIZED ANALYSES OF VARIANCE FOR SOME MORPHOLOGICAL CHARACTERS
WITH ESTIMATES OF GENOTYPIC AND PHENOTYPIC VARIANCES AND HERITABILITY.

		<i>Days to first flower.</i>	<i>Plant height at 160 days. (ins.)</i>	<i>Per cent. Plants per plot with blackarm lesions.</i>
Mean of all progenies	...	93.8	48.7	56
S.E. (Diff.)	...	2.8	2.7	About 9
Relative efficiency	...	117.5	106.9	112.5
C.V. per cent.	...	4.1	10.9	22.4

PARTITION OF THE VARIATION IN BP.52 MATERIAL.

<i>Source of variation.</i>	<i>d.f.</i>	<i>M.S.</i>	<i>M.S.</i>	<i>M.S.</i>
Strains in lines	17	18.58	78.35	1095.60
Progenies in strains	23	13.82	40.25	921.53
Error	80*	12.87	31.78	126.44
Genotypic variance	...	0.240	2.14	201.25
Phenotypic variance	...	3.455	10.06	230.38
"Heritability"	...	0.069	0.213	0.873

* 40 d.f. deducted for row and column adjustment.

Flowering for all progenies is shown in Table 2 to be rather later than is recorded in other cotton growing countries. Differences between progeny means, though statistically significant, were not large. The BAR progenies were somewhat earlier than all others.

Previous experience has shown that, with existing varieties, the period from sowing to final reaping is too extended to permit the highest yields from planting during the second rainy season. If, however, appreciably earlier maturing varieties could be evolved, later planting, which would be more convenient, might again be tried. Days to first flower is probably one of the more important characters in determining early maturity.

Flowering data were summarized from a population of 1,859 plants. The mean number of days to first flower was 92.9 at a mean node number of 7.12. These means would of course be affected by primary bud shedding so that they were also computed for the absolute first

flower. The mean number of days to absolute first flower were derived from 236 plants which bore a flower on the first node of the first sympodium and was 87.9 at an average node number of 6.61. Primary bud shedding was not therefore severe. Also it is shown that the very earliest mean days to first flower is considerably later than is recorded for other cotton growing countries. Genetic variance between progenies was low both for the original lines and for the new lines of BP.52. However the "heritability" for the former suggests that some selection advance may be expected. The parent-offspring correlation was correspondingly small ($r = +0.065$). It is worth noting that some of the small differences in days to flower tended to be reflected in maturity, discussed in a later section.

Plant height at 160 days was estimated from two plants in each plot. Table 2 shows that there were large and highly significant differences between strains. Further, the genetic variance and "heritability" suggest that at least part of the "main stem elongation" so characteristic of the BP.52 variety, may be genetic. No doubt the condition is exaggerated during seasons when primary bud shedding is severe.

Crop losses due to blackarm (*Xanthomonas malvacearum*) are probably the most important single factor affecting yield in Uganda. Some difficulty has been experienced at Kawanda in assessing resistance on the leaf spot technique of Dr. Knight. Further, under these conditions it has been observed that lesion formation appears often to be independent of the severe leaf spot phase. A modified lesion count technique devised by Mr. J. D. Jameson was therefore tried. In this, percentage of plants with one or more severe lesions are recorded for each plot. Table 2 shows that differences between strains in lines and between progenies in strains are considerably greater than could have occurred by chance.

Data from the 38 BP.52 progenies, transformed from percentages to degrees, were arranged in a histogram. The distribution indicated three well marked groups. Eight showed resistance equivalent to the class 3 to 38% with one or more lesions; 21 in the class 39 to 78%; and 9 in the class 79 to 100%. Such a segregation would fit a single factor hypothesis. This would suggest that the bulk of the selections in 1946-47 were heterozygous. Heritability was relatively high.

Summarized analyses of variance and covariance for the 38 BP.52 progenies, adjusted for rows and columns, and thereafter analysed as randomized complete blocks, are given in Table 3. Since one-third of the total degrees of freedom for estimating error were lost in the row and column adjustment for the lattice square, a corresponding reduction was made for the complete block arrangement. Some data for the lattice square are also included to show the precision of estimation of the yield components.

TABLE 3.

(1) SUMMARIZED ANALYSES OF VARIANCE FOR ALL PROGENIES FOR PRIMARY YIELD CHARACTERS.
 (2) SUMMARIZED VARIANCES AND COVARIANCES FOR 38 BP.52 PROGENIES.

		$X_1 = \text{Bolls per plant.}$	$X_2 = \text{Seeds per boll.}$	$X_3 = \text{Lint per Seed (cgms.).}$	$X_4 = \text{Lint per plant (grms.).}$
Mean of all ...	...	18.57	26.44	4.85	23.42
S.E. (Diff.) ...	...	3.58	1.49	2.32	4.14
Relative efficiency ...	...	115.2%	106.5%	113.8%	119.7%
C.V. ...	...	19.3%	5.6%	4.8%	17.7%

BP.52 PROGENIES ONLY.

Variances and Covariances.											
Variation.	d.f.	X_1^2	X_1X_2	X_2^2	X_1X_3	X_3^2	X_2X_3	X_4^2	X_1X_4	X_2X_4	X_3X_4
Replications (Squares)	3	58.890	+0.167	25.213	+1.300	0.353	-0.460	84.340	+70.023	+0.760	+1.147
Strains in lines	14	128.242***	-4.066***	11.686**	-1.308*	1.938**	-1.083**	52.398**	+70.146**	-4.603**	-4.727**
Progenies in strains	23	29.195**	-0.484*	3.708	+0.363	0.192**	-0.348**	58.474**	+39.393**	+0.185	+1.265**
Within progenies (error)	†74	10.947	-0.255	3.382	+0.659	0.082	-0.110	16.580	+12.312	-1.328	+0.038
TOTAL ...	151										

† 37 d.f. deducted for Row and Column adjustment. * $p = 0.05$ ** $p = 0.01$ *** $p = 0.001$.

Table 3 shows that differences due to progenies in strains are relatively large for most characters. Estimates of genotypic and phenotypic variances and covariances were derived from these and were used in discriminating between progenies.

Yield analyses converted to seed cotton per acre indicate that considerable yield improvements may be effected for BP.52. The yield level for the modal bulk was at the rate of 1,088 lb. of seed cotton per acre. This expanded figure is comparable with 1,030 obtained from an adjacent field of 2 acres.

Four BP.52 progenies, which are to be grown in the 1949-50 small bulks trial, gave an overall average yield of 1,493 lb. per acre. The four BAR strains similarly gave 1,102 lb. per acre; the comparative value for B.181 was 1,300, and 1,272 for N.17. Individual plants of BP.50 indicated that the yield would have been high, but losses in stand due to *Verticillium* wilt vitiated this comparison.

The application of the discriminant function technique as an aid to selection was effected in two ways. Firstly it was applied to the basic yield analysis—bolls per plant, seeds per boll and lint per seed; and secondly it was applied to the more important traits singly. With the selection pressure chosen for this experiment, the genetic advance to be expected is of the order of 12 to 15% of the mean of the population. This expectation will be checked by testing the selected material against the same modal bulk in the 1949-50 trial.

(b) Modal Bulk.

In contrast to the replicated progeny row breeding work, which is designed to exploit genetic variability, the modal bulk is an attempt to provide a uniform BP.52 nucleus for multiplication.

Means for the bulk were 5.22 centigrams of lint per seed with a C.V. of 9.0% ; 10.47 centigrams for seed weight with a C.V. of 8.7% ; and a mean maximum lint length of 29.5 millimetres with a C.V. of 5.4%. The reduction of variability is demonstrated by comparison with the respective coefficients of variation for the previous season ; that for lint per seed being 14.0% and for lint length 6.0%. Selection for uniformity consisted of discarding plants falling in both upper and lower tails of the frequency arrays of important seed cotton characters.

Five hundred single plants were selected on the basis of plant habit from the modal bulk. The seed cotton from these was analysed in turn for lint per seed, seed weight and mean maximum lint length. All plants outside the range plus or minus one standard deviation were discarded from the lint per seed array. This left 349 for the seed weight array, from which 98 were similarly discarded. Finally 84 were discarded from the lint length array leaving 167 plants from which the new modal bulk will be made.

AGRONOMY.

The importance of early maturity has been mentioned in a previous section. Detailed observations were made during the season for yields at each picking. Appreciable differences were recorded between progenies and an arbitrary division was made for those progenies from which more or less than 40% of the crop was reaped at 201 days after sowing. The resulting "early" and "late" groups reflected small but consistent differences in "flowering." Actual seed cotton yields of the early group were at the rate of 595 lb. at 201 days and 455 for the late group at the same date. Differences were small at the end of the season when the mean yield of the early group was 1,329 compared to 1,234 for the late.

It has been suggested that later planting (July or August) usually provides a crop of moderate cropping capacity (about 600 lb. per acre) which can be reaped at relatively small cost in three pickings. By contrast it is assumed that earlier planting (late May and June), though providing greater yields, involves a larger number of more costly pickings. During this season June planted cotton at a spacing of 3 feet $\times$ 2 feet yielded about 600 lb. seed cotton per acre at the third effective picking. Later pickings brought the total up to about 900 lb. There was no evidence that the individual pickings were more costly for the earlier than for the later sown plots.

ANNUAL 20-ACRE MULTIPLICATION OF BP.52.

Records are available for the past eight seasons of yields from sowings in various months from May to August. Large fertility differences, due to the various stages of cultivation after a grass ley, tend to obscure the smaller differences resulting from time of planting.

However from the data summarized in Table 4 there is strong evidence that both seasonal and average yields are highest for June plantings. Further, the high yields for some sowings in May suggest that the optimum sowing date would be nearer May than July and therefore supports the inferences in previous reports, namely, that early June is the optimum sowing date for the area represented by Kawanda.

TABLE 4.
SUMMARIZED YIELDS PER ACRE OF TOTAL SEED COTTON FROM THE
20-ACRE INCREASE AT KAWANDA 1941-42 TO 1948-49,
ACREAGES IN PARENTHESES.

Season.	Month of Planting.					Seasonal Means.	Seasonal Acreage.
	April.	May.	June.	July.	August.		
1941-42 ...	—	785 (18.0)	787 (1.9)	—	—	785.1	19.9
1942-43 ...	—	1,008 (6.2)	977 (12.0)	763 (2.0)	—	965.3	20.2
1943-44 ...	—	611 (6.1)	526 (10.9)	376 (3.9)	—	522.8	20.9
1944-45 ...	241 (3.2)	333 (10.7)	886 (5.1)	712 (4.1)	—	509.6	23.1
1945-46 ...	—	—	1,027 (6.5)	911 (10.7)	731 (3.3)	918.8	20.5
1946-47 ...	—	585 (5.6)	624 (4.4)	572 (7.5)	573 (5.0)	585.6	22.5
1947-48 ...	—	918 (5.2)	778 (0.4)	643 (16.1)	422 (1.9)	688.1	23.6
1948-49 ...	—	704 (2.2)	879 (7.0)	590 (9.1)	591 (14.2)	660.4	32.5
Means ...	241 (3.2)	690 (54.0)	816 (48.2)	668 (53.4)	593 (24.4)	696.0	22.9
Percent. stains	36.1	11.1	4.9	9.2	10.4	—	—

Average yield per acre of total seed cotton = 696 lb.

PROGRAMME FOR 1949-50.

Plans are now complete for the transfer of the BP.52 breeding work to the E.C.G.C. station at Namulonge.

(a) Cotton Research Station, Namulonge.

(1) Progeny rows from selected single plants of BP.52 will be grown in a lattice square arrangement. The possibilities of the discriminant function technique as an aid to further improvement in yield will be studied in greater detail.

(2) Small bulks of the most promising strains of the 1948-49 season will be tested against the standard variety.

(3) Modal bulks of BP.52 and the most promising of the early blackarm resistant lines will be grown for sorting at the end of the season.

(b) Agricultural Research Station, Kawanda.

(1) Completion of the fertiliser programme in co-operation with Dr. Griffith.

(2) Summarising with Dr. Griffith the current results of studies on the accumulation of soil nitrates.

ANGLO-EGYPTIAN SUDAN.

PROGRESS REPORT OF THE PLANT BREEDING STATIONS, SEASON 1948-1949.

BY

R. R. ANSON, R. L. KNIGHT AND M. F. ROSE.

PLANTING AND PICKING DATES.

Area.	Average Planting Dates.	Average Picking Dates.	Close Season.
Gezira... ..	10th Aug.-15th Sept.	30th Dec.-1st April	15th April-10th Aug.
Gash Delta	20th Aug.-20th Sept.	10th Jan.-30th April	30th April-20th Aug.
Tokar	7th Sept.-15th Oct.	1st Jan.-31st May	1st June-20th Aug.
Kordofan	15th June-15th Aug.	15th Oct.-1st March	1st March-15th June
Zeidab	1st May-15th May	1st Sept.-30th Sept.	1st Jan.-30th April
Equatoria	15th May-31st Aug.	1st Oct.-15th Feb.	31st March-15th May

INTRODUCTORY NOTE.

Egyptian irrigated and flood grown cotton.

Gezira.—The total area planted by the Sudan Plantations Syndicate and the Kassala Cotton Company amounted to 206,778 acres, of which 104,834 were Domains Sakel (S. Cotton) and 101,944 acres X.1730A strain (L. cotton). The Domains Sakel area comprised 30,174 acres of D.S.1 (Evelyn's Selected) and 74,660 acres of Domains Sakel General. The average yield obtained from these two strains was 1,296 and 1,213 lb. of seed cotton per acre respectively. In addition to this, the total irrigated area sown by Government and private Schemes on the White Nile amounted to 33,241 acres (all "L" cotton).

The Gezira crop slightly exceeded the estimate of 1,310 lb. seed cotton per acre, the actual average yield for the 206,778 acres being 1,338 lb., but grade was below average. This low grade was attributed mainly to adverse weather conditions—late rains and a long cold winter. Asal was also worse than usual throughout the Gezira and might well be concerned. The cold weather delayed ripening and boll opening. Plants appeared to suffer from water strain, a condition which forced the bolls to open in one flush and cause unavoidable admixture of mature and immature cotton at picking time. Many bolls failed to mature.

Gash Delta.—The effective area amounted to 46,537 acres comprising 19,460½ Domains Sakel and 27,076½ X.1730. Here again, the crop slightly exceeded the estimate, and averaged 689 lb. seed cotton per acre. There were instances of bad boll opening, but these were few and far between. Seed cotton was well up to average grade. In places Egyptian bollworm was severe. Cattle trespass is thought to have considerably reduced yield in some areas. Propagation areas of blackarm resistant Domains Sakel and X.1730 strains have yielded well and produced good quality lint. The seed obtained from these areas will be tested in the Gezira next season against the present commercial strains.

Tokar.—The effective area amounted to 20,685 acres (L. cotton); the average yield is estimated at 483 lb. seed cotton per acre, almost half

last season's yield. Cold, cloudy sunless conditions were thought to be the cause of bad and delayed boll opening, and dull damp conditions brought about one of the most severe spreads of asal* which Tokar has yet experienced.

Zeidab.—(5,001 acres American long staple, irrigated). The variety grown is a particularly long stapled ($1\frac{15}{32}$ "), early maturing strain of Coker Wilds.

Most of the crop was picked before pink bollworm, one of the most serious pests at Zeidab, reached its peak. The average yield per acre amounted to 1,134 lb. of seed cotton.

American rain grown cotton.

This season shows the production of American cotton in the Sudan rapidly approaching its pre-war figure.

Kordofan Province.—(Area 65,806 acres, American long staple, $1\frac{1}{8}$ "). Rains started normally but there was a serious drought in August which greatly reduced the yield. The factories for the seven cotton growing centres, namely Dilling, Kadugli, Talodi, Koloji, Abu Gebeiha, Umm Berembeita and Lagowa, were all in action again for the first time since the war. Apart from Lagowa which grew a collection of mixed (American long staple) strains, all areas were sown with BAR.SP.84, a blackarm and jassid resistant, early maturing strain produced by this section. Comprehensive tests throughout this tract have proved BAR.SP.84 most suitable to the general conditions. The average yield for Kordofan was 307 lb. seed cotton per acre.

Equatoria.—Variety BAR.SP.84 (American long staple). The total area under cultivation amounted to 9,485 acres. Roughly 3,200 acres of this amount were grown at Meridi and 6,285 at Yambio. The yield averaged 360 lb. seed cotton per acre, considerably less than last season. This might be partly attributable to late sowing and partly to poor viability and consequent bad germination of sowing seed, which, for the past three seasons, has caused considerable concern. Comprehensive experiments designed to discover the cause of this bad germination are being carried out at the Yambio Experimental Farm.

Results to date indicate that sowing seed should be collected only from high grades of early pickings. Seed picked late in the season is less viable, partly because of stainer damage, and partly because material left in the field is more liable to storm damage. Peasants are being instructed to pick at frequent intervals and to ensure that pickings are dried thoroughly before storing.

Time of planting experiments confirmed previous findings, i.e. early sowing 15th May—15th June produces best results in both yield and quality. At Meridi, although the area was somewhat less than that of last season, there was a higher percentage of Grade 1 cotton (52 per cent.—34 per cent.) which is encouraging. The new wave of pure BAR.SP.84 seed grown in isolation on the seed farm yielded exceptionally well.

* See Appendix.

THE GEZIRA STATION.

BY

R. R. ANSON.

METEOROLOGY.

Late rains followed by a long cold winter were the two most inclement and harmful features experienced during the season. The wet season ended during the second week in October.

Average monthly readings were :—

Month.	Average Maximum Temperature.	Average Minimum. Temperature.	Average relative humidity 8 a.m.	Total Rainfall mm
April, 1948	108.7	70.9	19	—
May, 1948	107.2	72.0	33	20.3
June, 1948	100.8	74.1	58	70.3
July, 1948	99.0	72.1	66	150.5
August, 1948	93.0	72.0	79	97.1
September, 1948	95.0	70.9	74	97.3
October, 1948	98.8	68.9	51	11.1
November, 1948	97.2	62.8	36	—
December, 1948	91.9	57.0	39	—
January, 1949	92.7	55.4	44	—
February, 1949	92.5	55.2	27	—
March, 1949	101.8	63.5	21	tr.

BREEDING AND VARIETY TESTING.

The breeding plot was sown at the normal time (11th August, 1948), two days after rain, and given a light watering directly after sowing. Germination was good. Towards the end of the month (22nd August, 1948) plants were dusted with benzene hexachloride against flea beetle. Termite damage was negligible. Strains D.S.2, D.S.3 and R.D.S. were infected with blackarm (primary infection). Weather conditions favoured the disease and by 27th September, 1948, it had spread throughout the plot. Susceptible plants were severely attacked and shed lower leaves and first formed sympodia so extensively that one experiment ("Boll tagging at 14 day intervals for observations on grade") had to be abandoned.

The following material was planted and analysed :—

Domains Sakel.

1. J.R. 14/5 (containing H_1H_1 and derived from J.R. 9/5 $\times$ D.S.17) was sown in rows and alternated with D.S.1 (control). Samples have been forwarded to the Shirley Institute to ascertain whether the addition of H_1 is likely to affect lint quality.

2. *Domains Sakel*.—Six plants selected for low node numbers (earliness) were propagated in progeny rows. Pure breeding re-selections will be carried forward.

3. BAR.14/1 (Blackarm resistant Sakel carrying B_2)—Nineteen selections made from a 300 plant random plot filter of this strain were grown in progeny rows and bulk analysed. Twelve of these will be carried forward to form new filtered material of BAR.14/1.

4. BAR.14/7 (Blackarm resistant Sakel B_2) occupied half an angia (41 rows of 25 plants). A few selections and 20 plant diagrams were made from material within it. However, new material BLR.14/16, of similar composition, but carrying resistance to both leafcurl and blackarm will be available next season. Selection and filtering work on this new material will be given first priority.

X.1730 Types.

1. *BAR.4/16* (Leafcurl and blackarm resistant strain carrying B_2 and B_3).—Eighteen outstanding selections from the analysis of 300 random plants grown at G.R.F. in the 47/48 season were planted in progeny rows and bulk analysed. Six of these have passed the quality, regularity and improved yield tests and will be carried on to form a new filter of *BAR.4/16*.

2. (*BAR.4/11* $\times$ *X.1730A*).— F_1 was backcrossed to *X.1730A* and the product supplied to Shambat for out of season propagation in the winter of 1948/49.

3. *BAR.XL* (7th B/C B_2).—Three selections from *BAR.XL-44/48-46/48* were sown in the breeding plot as small bulks. Plant diagrams were made from these but no selection nor filtering work was done on them because it was decided to give full emphasis to work on the two fully resistant strains *BAR.4/11* and *BAR.4/16*. This also applied to the *BAR.XL-1* bulks 47/48 and 48/48 and to the *BAR.XL-2* bulks 49/48 and 50/48.

4. *J.R.1530* (A hairy, high yielding strain showing some resistance to jassid).—Fifty-three progeny rows were analysed. The best six of these will be carried on for further analysis next season.

Leafcurl resistance.

In the last E.C.G.C. Progress Report (1947/48) Evelyn described an experiment designed by him to determine what degree of resistance was actually present in *X.1730A* and its *BAR* counter-parts when exposed to conditions favouring leafcurl infection.

It will be remembered that there was no leafcurl observed up to 31st March, 1948, and that further observations made after cutting back produced the following surprising results :—

Observation Dates. Recorded fortnightly from 1st October.							
		<i>X.1730A.</i>	<i>BAR.</i> <i>1730L.</i>	<i>BAR.</i> <i>4/5.</i>	<i>BAR.</i> <i>4/11.</i>	<i>BAR.</i> <i>4/16.</i>	<i>X.1730A</i> <i>Spreaders.</i>
% infection A	...	33.5	43.5	42.8	58.0	38.5	None
" " B	...	56.0	64.0	54.8	62.5	49.5	"
A at 30th April, 1948.					B at 19th June, 1948.		

It was thought that, by eliminating all infected plants and bulking resistant ones, it might be possible to produce a strain very highly resistant to the disease. With this end in view, all plants showing any infection were uprooted and remaining uninfected plants were again ratooned (20th February, 1949) and subjected to infection.

Results were very satisfactory in that only two of the remaining plants, both from *X.1730A*, contracted the disease after the second cut back. These second ratoons were allowed to continue until 26th March, 1949, by which time sufficient quantities of self-bred seed had been collected from each strain. The numbers of resistant plants obtained were :—

BAR.1730L-16 plants, *BAR.4/5-15* plants, *BAR.4/11-17* plants, *BAR.4/16-22* plants and *X.1730A-20* plants.

Small bulk propagation areas for each of these strains will be grown in isolation next season.

Leafcurl resistant Domains Sakel and 1730 strains were grown in randomised blocks with 10 replications. Each plant of each strain was alternated with "Spreader" plants, as in previous years. The experiment was sown on 15th September, 1948.

Sakel Series.—Strains under test included :—

- (1) Free plants of R.D.S. 1-4 from leafcurl Experiment 47/48.
- (2) Bulk of R.D.S. 1-4 from progeny rows 47/48 with lint length 39 mm.
- (3) Bulk of R.L.S. 1-4 from progeny rows 47/48 with lint length 36.6 mm.
- (4) Bulk self-bred seed selected from Abdel Magid R.D.S., with good lint.
- (5) Bulk self-bred Domains Sakel Control of 47/48 lint length 36.2-38.8 mm.
- (6) R.14/1-1/48 lint length 41-43.8 mm.
- (7) BAR.14/7 (BAR. Dom. Sakel, B₂).
- (8) Commercial Domains Sakel ex Gash.

The following table gives % leafcurl infection at 30th April, 1949, end of picking.

4	2	3	1	6	7	5	8
12.5%	12.5%	14.3%	20.0%	38.5%	88.0%	89.5%	94.0%

% of leaf curl infection 15 days after cutting back.

2	4	3	1	6	7	8	5
23.0%	27.5%	28.8%	30.5%	43.0%	92.0%	94.0%	94.0%

In the strains numbered 1-4 leafcurl did not develop until late in the season. Varieties in brackets do not differ significantly at the 5% level.

X.1730 Series.—Strains under test included :—

1. X.1730A ex Gash.
2. BAR.XL. ex Gash.
3. BAR.XL 1 ex Hamid el Nil.
4. BAR.4/5 ex Gash.
5. BAR.4/16 ex Hamid el Nil.

% leafcurl infection when plants were cut back on 30th April, 1949.

5	2	3	4	1
2.0%	8.0%	8.5%	12.5%	14.5%

% leafcurl infection 15 days after cutting back.

5	2	3	1	4
6.0%	12.0%	17.5%	21.0%	25.5%

On neither date was there any significant difference.

Cotton Varietal Tests.

Varietal testing was carried out on the usual sites—Turabi in the north, Gezira Research Farm in the centre and Hag Abdullah in the southern portion of the Gezira. Sowing was completed on 14th-15th August, 1948, 13th August, 1948, and 11th August, 1948, respectively.

At Turabi a slight outbreak of primary blackarm occurred, but weather conditions were not conducive to spread; it therefore soon dried out and was not at any time severe. At the Gezira Research Farm however, weather conditions were most favourable for blackarm spread, so much so, that all sub-plots were heavily infected. Unfortunate as this may have been in one sense, in another it was most fortunate, because it provided the best test that the resistant strains could have had and valuable information which might otherwise have taken years to obtain. It has been an object lesson which has given a clear-cut example enabling an accurate assessment to be made of the relative values of varying degrees of blackarm resistance, in a bad blackarm year.

At Hag Abdullah the outbreak was considerable but much less severe. The three varietal tests have therefore provided evidence showing the relative values of blackarm resistant strains under mild (Turabi), considerable (Hag Abdullah) and very severe (G.R.F.) degrees of infection. The following results indicate the "Insurance" value of the resistance genes B_2 and B_3 .

GEZIRA VARIETY TRIALS 1948-49.

Yields of Seed Cotton and Lint in pounds per acre and percentage ginning out-turn.

Variety.	BAR. Genes.	G.R.F.			Turabi.			Hag Abdullah.		
		Seed cotton	Lint	G.O.T.	Seed cotton	Lint	G.O.T.	Seed cotton	Lint	G.O.T.
D.S. ...	—	1290.6	413.0	32.0	1246.4	428.8	34.4	731.5	217.3	29.7
D.S.1 ...	—	1262.0	403.8	32.0	1226.2	424.3	34.6	658.9	197.0	29.9
D.S.2 ...	—	1003.3	321.1	32.0	1223.6	427.0	34.9	654.1	199.5	30.5
D.S.S. mixed ...	—	1024.9	330.0	32.2	1194.4	420.4	35.2	654.4	200.9	30.7
X.A.G. ...	—	1736.2	609.4	35.1	1357.9	499.7	36.8	1120.0	370.7	33.1
X.A.T. ...	—	1708.9	603.2	35.3	1317.6	487.5	37.0	1100.0	368.5	33.5
BAR.XL ...	B_2	1977.9	710.1	35.9	1250.2	462.6	37.0	1227.4	421.0	34.3
BAR.XL1 ...	B_2	2087.8	730.7	35.0	1256.7	460.0	36.6	1242.6	418.8	33.7
BAR.XL2 ...	B_2	1961.0	680.5	34.7	1250.6	451.5	36.1	1284.1	427.6	33.3
BAR.4/5 ...	B_2	2046.0	679.3	33.2	1199.1	417.3	34.8	1207.0	385.0	31.9
BAR.14/7 ...	B_2	1627.2	476.8	29.3	—	—	—	—	—	—
R.D.S. ...	—	767.6	261.8	34.1	—	—	—	—	—	—
BAR.4/16 ...	B_2B_3	2198.6	736.5	33.5	—	—	—	—	—	—
JR.1530 ...	—	1470.9	553.1	37.6	—	—	—	—	—	—

At the 5% level the significant differences for seed cotton were 169.2 and 137.2 lb. per acre at the G.R.F. and Hag Abdullah respectively. At Turabi there was no significance. Owing to pressure of work all replications were bulked before ginning so no analysis of lint yields and G.O.T. was possible.

X.A.G., X.A.T., BAR.XL, BAR.XL1, BAR.XL2, BAR.4/5 and BAR.4/16 are all X.1730 derivatives.

D.S., D.S.1, D.S.2, D.S.S. mixed, R.D.S. (Leafcurl resistant Sakel), BAR.14/7 are Domains Sakel derivatives.

JR.1530 (Hairy 1530 strain), D.S.2, R.D.S. and D.S.S. mixed all had primary infection of blackarm.

HAIR WEIGHT AND SPINNING TEST COMPARISONS BETWEEN DOMAINS SAKEL AND EVELYN'S SAKEL.

Strain.	Effective Length (32nds).	Standard Hair Wt.	Maturity N—D.	Highest Standard Count.	Lea Products.			
					80s	100s	120s	
Average of 29 Large Scale Tests.								
Domains Sakel	47.8	142.5	63.9-8.2	103.3	2572	2287	2036	
Evelyn's Sakel	47.8	139.5	63.5-8.8	105.3	2599	2299	1975	
Average of 8 Small Scale Tests.								
Domains Sakel	49 (1)	133.0 (1)	—	—	2058	—	—	
Evelyn's Sakel	49 (1)	136.0 (1)	—	—	2169	—	—	

(1) = one test only.

Evelyn's cotton is slightly better than Domains Sakel in most tests.

GRADE EXPERIMENT.

At the Gezira Research Farm, grade was so low throughout that the many experiments designed to throw light on factors thought to influence it gave very disappointing results.

1. *Sowing Date and Spacing Observations, Plot 52.*—This plot contained two replications of 5 sowing dates and two spacings, viz. 35 cm. $\times$ 80 cm. thinned to 3 plants per hole and 50 cm. $\times$ 80 cm. thinned to 1 plant per hole. The number of holes per ridge at 35 cm. was 33, and at 50 cm., 22. Germination was excellent, but grasshoppers did some damage to earliest sown cotton (23rd June, 1948). Gaps thus caused were filled by transplanting seedlings at thinning time (30th June, 1948). No resowings were necessary on the later sowing dates. On 4th November, 1948, some severe cases of wilt were observed. These were mostly found on early sowing dates and there were more in the 50 cm. spacing treatments than in the 35 cm. spacing treatments. Infected plants shed all leaves and appeared dead, but later recovered and put on new growth. Two wilt infected plants were uprooted and examined by the Plant Pathologist who stated in his report "The roots looked healthy—no sign of termites or stemborer. Although the main tap root looked normal there was a suggestion of rotting at the ends of a *few* of the finer laterals but from what could be seen not enough to cause wilt of such severity."

The following table gives results of yield and grade of each picking.

PLOT 52 G.R.F. GRADE EXPERIMENT.

1948/49.

Sowing Date.	Pickings.									300 boll* samples	Total Rottles	Grade Average
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th			
	20/11/48	2/12/48	9/12	18/12	1/1/49	9/1	23/1	15/2	13/3			
23/6/48 (35 cms.) ...	5.4	2.6	1.9	3.6	3.6	1.1	0.3	0.2	0.3	1.6	20.6	4.8
Grade ...	3	4	x5	x5	6	6	6					
23/6/48 (50 cms.) ...	1.8	0.5	1.5	3.7	3.9	1.2	0.6	0.2	0.2	1.4	15.0	5.8
Grade ...	5	6	6	6	6	6	6					
7/7/48 (35 cms.) ...	—	1.8	2.8	5.1	5.3	1.1	0.5	0.2	0.3	1.4	18.5	5.4
Grade ...	—	x5	5	5	6	6	6					
7/7/48 (50 cms.) ...	—	0.4	0.9	3.2	4.9	2.1	0.8	0.2	0.1	1.3	13.9	5.7
Grade ...	—	6	6	6	5	6	5					
21/7/48 (35 cms.) ...	—	—	—	3.5	6.4	1.8	0.8	0.2	0.1	1.3	14.1	5.7
Grade ...	—	—	—	6	5	6	6					
21/7/48 (50 cms.) ...	—	—	—	1.3	6.0	2.6	0.6	0.2	0.1	1.5	12.3	5.7
Grade ...	—	—	—	6	5	6	6					
4/8/48 (35 cms.) ...	—	—	—	—	6.9	2.3	1.1	0.2	—	1.3	11.8	5.3
Grade ...	—	—	—	—	5	5	6					
4/8/48 (50 cms.) ...	—	—	—	—	4.8	3.2	2.6	0.6	—	1.5	12.7	5.3
Grade ...	—	—	—	—	5	5	6					
18/8/48 (35 cms.) ...	(Control)	—	—	—	0.2	1.1	1.7	0.5	—	1.1	4.6	5.8
Grade ...	—	—	—	—	6	6	x6					
18/8/48 (50 cms.) ...	(Control)	—	—	—	0.2	0.6	4.1	3.6	0.1	1.4	10.0	6.0
Grade ...	—	—	—	—	6	6	6					

* 100 boll samples were taken from the first 3 pickings of each treatment.

Average boll weights for wide spacings remained fairly constant but weights from close spacing decreased with later sowing dates. Last pickings were too small, they could not therefore be graded.

Severe wilt probably reduced the yield and the grade in the early sown 50 cm. spacings. However, one cannot lay much stress upon results from insufficiently replicated observation plots.

It has, however, indicated that early sowings may increase yield and, next season, experiments will be designed to ascertain whether this is so. At the moment 21st July is about the earliest date the Sudan Plantations Syndicate can get water. 18th August is about the average present sowing date.

2. *Wind Break Observation. Plot 27.*—There were 4 treatments. Each treatment occupied 1 acre (approx.).

1. Exposed to south wind.
2. Completely surrounded by 8 rows of *durā* (sorghum).
3. Completely surrounded by 8 rows of *Ads* (*Cajanus indicus*).
4. Exposed to north wind.

It was thought that the hot dry desiccating northerly winds which usually start at the end of October and continue throughout most of the picking period might have an adverse effect on grade. For the first two pickings the sheltered treatments showed a slight advantage, but for the remaining 4 pickings there was little to choose between treatments. However, that which had been exposed to the north wind gave the worst grade throughout. Results might have been more conclusive had conditions been normal but premature boll opening, a condition which was general throughout the Gezira, probably masked any advantages.

3. *Type of Picking. Plot 242.*—There were two treatments.

- (a) Picking every seven days.
- (b) Picking every fourteen days.

The grade for both treatments was exceptionally low and differences fell very short of significance.

4. *Sowing Date and Spacing. Plot 244.*—The experiment was set out in the form of a factorial 2×2 design.

There were 4 treatments.

- (a) Close spaced early sown (35 cm. $\times$ 80 cm. sown 25th July).
- (b) Close spaced late sown (35 cm. $\times$ 80 cm. sown 15th August).
- (c) Wide spaced early sown (70 cm. $\times$ 80 cm. sown 25th July).
- (d) Wide spaced late sown (70 cm. $\times$ 80 cm. sown 15th August).

At the 5% level early planting was significantly better than late plantings but there was no significant difference between spacings.

Significant interaction indicated that early planting combined with wide spacing resulted in better grade.

5. *Good and Bad Seed. Plot 246.*—There were two treatments.

(a) Seed from Grade 1 cotton ex Gash.

(b) Seed from Grade 4 cotton ex Gash.

There was no significant difference between treatments.

6. *Grade Trial Miscellaneous. Plot 246.*—Treatments.

(a) Normal procedure.

(b) Heavy sowing (40 seeds per hole).

(c) Heavy resowing.

(d) Delayed thinning.

At the 5% level there was no significant difference between treatments.

PESTS AND DISEASE.

White fly was worse than usual and may have accounted for asal spread. *Asal* was considerably worse than usual.

Thrips, in contrast to last season, did very little damage.

Egyptian and pink bollworm.—Neither appeared to be worse than usual although pink bollworm larvae seemed to be more in evidence on the seed cotton at ginning time.

Jassids were present but plants were not severely attacked.

Blackarm.—Primary infection caused considerable damage to cotton at the Gezira Research Farm. This primary infection was traced to seed which had obviously been inadequately treated with "Abavit B" and had not been put through a delinting machine after ginning. Some seed had immature lint still adhering to it, which prevented the "Abavit B" dust penetrating to the seed coat. This severe outbreak of blackarm has caused a general tightening up of precautions. A delinting machine has been erected and next season a stronger concentration of Abavit B is to be used. Small bulks of seed to be grown in the varietal tests, breeding plots and observation plots are to be delinted with sulphuric acid before Abavit treatments.

SUMMARY OF MAIN CONCLUSIONS.

1. *Domains Sakel and D.S.1.*—In the Varietal Tests there was no significant difference in yield between D.S. and D.S.1 at any of the three sites in which they were tested. Averages taken from 29 large and 8 small spinning tests showed D.S.1 to be slightly stronger and finer than Domains Sakel.

2. *X.1730A ex Gash and Tokar*.—These strains again gave identical returns and did not differ in any way. From small scale spinning tests received from the Shirley Institute, fibre characters were identical.

3. Blackarm resistant strains significantly outyielded susceptible strains when there was severe blackarm infection present.

4. Strains of Domain Sakel highly resistant to leafcurl have been obtained. However, these will most probably be replaced by BLR.14/16, which contains resistance to both leafcurl and to blackarm.

PROGRAMME FOR 1949-1950.

All lines of work shown in this report will be continued. Emphasis will be given to work on blackarm and leafcurl resistant Sakels, and to 1730 strains carrying the two factors for blackarm resistance B_2 and B_3 .

SHAMBAT STATION.

BY

R. L. KNIGHT.

METEOROLOGY.

Rains started in May and finished in October, but the total rainfall for the year was only 2.8 inches—less than half the normal. Humidity was good, however, during the critical part of the season, and blackarm inoculations “took” well.

The season was less hot than usual and there was a long cool winter. Unfortunately, leafcurl was so severe in the in-season crop that the out-of-season season planting was delayed, with the result that the crop did not benefit to the full from the coolness. In the period 1st May, 1948, to 30th April, 1949, inclusive, there were 204 days when the shade temperature registered 100°F. or over, 28 days with 110°F. or more, and no days with a temperature of 115°F. or over. These figures compare with 204, 34 and 3 days respectively, representing the average of the previous six seasons.

GENETICS AND BREEDING.

BLACKARM RESISTANCE.

1. *Production of blackarm resistant "Egyptian Varieties."*

(a) *Blackarm resistant Domains Sakel.*—In my last season's report it was stated that a 5-acre propagation area of Evelyn's Selected Domains Sakel, homozygous for B₂, was grown under the number BAR.14/7 in 1947-48 winter. Part of the seed from this plot was used for sowing 105 acres in the Gash this season, and a small quantity was used for sowing in a replicated variety test at Medani, where it yielded 476.8 lb. lint per acre as against 387 lb. from the parental Sakel control. This large difference in yield was due to severe blackarm attack in the early part of the season before the rains ceased.

It will be remembered that within this out-of-season 5-acre plot of BAR.14/7 two acres were selected as showing a high incidence of leafcurl. At the end of crop these two acres were heavily rogued for leafcurl, 17,310 diseased plants being pulled out and 3,847 healthy ones left. These leafcurl free plants were then cut back hard to induce secondary growth thereby making any latent leafcurl manifest itself. By 2nd October, 1948, these 3,847 plants had been reduced by regular leafcurl roguing to 632 healthy plants but, of these, 390 had not at that date set a boll on their secondary growth. These plants were presumed to be lacking in vigour and, since vigour is desirable of itself, and the lack of it tends to mask leafcurl, these 390 plants were pulled up. The remaining 242 plants were allowed to flower freely (being isolated) and were later bulk-picked as the leafcurl resistant component of the blackarm resistant strain, BAR.14/7. The new strain was given the number BLR.14/16.

The seed of the 242 leafcurl free plants was used to sow a 1 acre propagation area of BLR.14/16 at Shambat in 1948/49 winter, and this, at the end of crop, will be cut back and rogued for leafcurl again. A small quantity of seed was also sent to Medani for inclusion in a replicated leafcurl resistance trial, the results of which for the three varieties concerned are extracted below.

<i>Variety.</i>			<i>% leafcurl.</i>
Evelyn's Sakel ...	...	...	97
BAR.14/7 ...	...	...	79
BLR.14/16 ...	...	...	11

Further details as to this system of breeding for leafcurl resistance, the system of grading used and the genetic background of the work are given elsewhere (Hutchinson & Knight, 1950).

The synthesis of a Domains Sakel type of similar parentage to BAR.14/7, but carrying both B_2 and B_3 , was held up by a severe attack of leafcurl. The B_2B_3 plants, though not producing enough seed for propagation, were utilized by crossing them with BLR.14/16 so as to combine leafcurl resistance with blackarm resistance. Two crosses with BLR.14/16 followed by roguing for leafcurl should be adequate for this purpose.

In the transference of the *arboreum* gene B_4 to Evelyn's Selected Sakel, homozygous B_4 plants of 10th *barbadense* backcross composition (6th backcross to Evelyn's Sakel) were raised, and seed of these will sow a small propagation plot of the B_4 Sakel next season.

In a second transference from tetraploid *sanguineum* (*G. arboreum* race *bengalense*, Silow) to Sakel, 43 plants of second Sakel backcross type were raised and selections within these were again successfully crossed with Sakel. In this experiment the objectives are three-fold: (a) to find out whether a second transfer of B_4 by this technique will produce a B_4 Sakel with this gene at the same locus as in the material from the first transference, (b) to see if a strong intensifier of B_4 , thought to exist in *arboreum*, can be transferred, and (c) to transfer an *arboreum* hairiness gene to Sakel.

In the hybridization between tetraploid *herbaceum* (Wagad 8) and Sakel the second backcross to the latter, comprising 21 plants, was successfully raised and selected plants in it were again crossed with Sakel. Some of these plants showed marked blackarm resistance and some marked hairiness.

Hybridization involving the perennial *barbadense* type Grenadines White Pollen reached the third Sakel backcross stage and the resistance of this type has been shown to depend on a major gene, B_5 , fortified by minor genes. This work has been published in greater detail elsewhere (Knight, 1950).

(b) *Blackarm resistant XI730*.—Three blackarm resistant strains of XI730 were on trial in the Gezira this season: BAR.1730L, BAR.4/5 and BAR.4/16. Full details of these trials will be found in the report for the Gezira Station (Medani). Twenty-six comparisons of XI730L, and twenty of BAR.4/5, with XI730A, spread over a number of seasons, are now available and the averaged figures in pounds of lint per acre for these replicated trials are given below.

				BAR.1730L	BAR.4/5
Variety	...	...	...	537	470
Control (XI730A)	...	...	...	537	505

Though BAR.4/5 is inferior in yielding power, XI730L is clearly the equal of XI730A and its spinning tests over a number of years show it to be identical in lint quality also (see p. 61 of my 1946-47 Report: subsequent tests have continued to bear these figures out).

In my last season's Report (p. 57) the inferiority in the yielding power of BAR.4/5 and BAR.4/11 was attributed to the high proportion of X1730H "blood" in these two strains. To obviate this BAR.4/11 was crossed with X1730A on a wide basis and the F_1 backcrossed to X1730A. The F_1 of this backcross was grown in 1948-49 winter and F_2 seed has been produced for sowing next season. From this an X1730A type homozygous for B_2 and B_3 will be bred.

2. *Production of blackarm resistant strains of American Upland for the Southern Sudan and the examination of imported Upland types.*

(a) *Blackarm resistant Uganda SP.84.*—A propagation area of BAR.SP.84 homozygous for B_2 and B_3 was grown this season and some 5,000 lb. of pure seed was produced. This type is the BAR.7/8 mentioned in my last report.

(b) *Blackarm resistance of imported Uplands.*—The degree of blackarm resistance shown by KP.28 from Uganda, and L.S.S., Victory, 216F, 199F, 244F and 268F from India was given in my 1947-48 Report (p. 58). This season, F_2 s of hybrids of these types with Sakel and with B_2 Sakel were grown. Five F_2 progenies of each variety were raised in each of the above series but for brevity these have been shown below as totals. 216F was not included in these tests since it carried only about 20% of resistant plants and these all showed typical B_2 resistance.

F_2 S OF IMPORTED UPLANDS $\times$ SAKEL.
BLACKARM GRADE.

	" 4 "	" 5 "	" 6 "	" 7 "	" 8 "	" 9 "	" 10 "	" 12 "
Sakel controls	—	—	—	—	—	—	14	237
B_2 Sakel control	3	32	45	6	—	—	—	—
KP.28 $\times$ Sakel	15	61	96	34	12	5	14	48
L.S.S. $\times$ Sakel	45	232	166	46	21	8	26	86
Victory $\times$ Sakel	10	76	54	49	30	18	19	17
199F $\times$ Sakel	34	192	138	44	30	6	29	54
244F $\times$ Sakel	17	91	99	42	13	6	16	10
268F $\times$ Sakel	7	59	65	49	12	5	15	28

F_2 S OF IMPORTED UPLANDS B_2B_2 SAKEL.

	Resistant	Susceptible.
KP28 B_2B_2	99	—
L.S.S. B_2B_2	536	—
Victory B_2B_2	915	—
199F B_2B_2	298	—
244F B_2B_2	479	—
268F B_2B_2	310	—

Clearly in each of these varieties B_2 is the major gene responsible for resistance, but minor genes fortifying the resistance conferred by B_2 are also present. These minor genes are responsible for filling the gap between grades " 7 " and " 12 " in the F_2 s of these Upland $\times$ Sakel crosses.

3. Grading of American Cotton Belt varieties.

Twenty fresh importations of commercial Upland varieties from the U.S. Cotton Belt were sprayed with inoculum and graded for resistance, with the results tabulated below :

Variety.	Blackarm Grade.						
	" 4 "	" 5 "	" 6 "	" 7 "	" 8 "	" 9 "	" 10 "
Control BAR.SP.84 (B ₂) ...	4	51	6	—	—	—	—
" SUS.SP.84 (b ₂) ...	—	—	—	—	—	3	50
Acala 111 Rogers ...	—	—	—	—	—	4	10
Acala (Shafter P-18-C) ...	—	—	—	—	—	—	51
Rowden B.6 ...	—	—	—	—	24	23	—
Rowden 42a ...	—	—	—	—	—	32	16
Rowden 2088 ...	—	—	—	—	1	22	25
Mebane (Triumph) ...	—	—	—	—	—	3	17
Mebane ...	—	—	—	—	—	7	6
Nucala ...	—	—	—	—	—	—	47
Oklahoma Triumph " 44 " ...	—	—	—	—	1	8	34
Rhyne's Cook ...	—	—	—	—	1	16	30
Clewilt " 7 " ...	—	—	—	—	—	1	18
Coker " 100 " No. 6 ...	—	—	—	—	—	1	22
Delfos 9252 ...	—	—	—	—	—	—	1
Eltapine 14 ...	—	—	—	—	17	8	—
Express 6637 ...	—	—	—	—	—	6	22
Express 11384 ...	—	—	—	—	—	11	35
Stoneville 2B (8275) ...	—	—	—	—	2	15	7
Stoneville 2C (7303) ...	—	—	—	—	—	31	23
Wilds 16.Sc ...	—	—	—	—	—	6	46
Young's Acala ...	—	—	—	—	—	3	45

VARIOUS.

1. *Jassid Resistance*.—The economic and genetic background of this line of research was given in my last season's Report (p. 60). This season the work suffered by reason of a severe leafcurl attack on the 1947-48 and 1948-49 crops, and many progenies failed to produce seed. Nevertheless, the full hairiness of MU.8b was recovered in the F₂ of the second Sakel backcross, and third backcross progenies were raised in 1948-49 winter and selfed. Work with Ferguson has also continued on similar lines, but in all these transferences the hairiest plants in the early backcrosses suffer from marked sterility. Both in the MU.8b and Ferguson lines, however, there is evidence that this is breaking down in the third backcross material now growing out of season.

The basic hairiness gene from MU.8b was carried to the 6th Sakel backcross (the last two crosses having been to BAR.14/7) and this material was crossed with BLR.14/16 in 1948-49 winter to add leafcurl resistance. A similar course was adopted with the main H gene from Kapas Purao, *G. punctatum*, St. Ignatius, *G. tomentosum*, and *G. mustelinum*.

The success of this work will depend ultimately on lint tests. There can be no doubt that the full hairiness of several of these *hirsutum* types can be transferred to Sakel, but none of the transferences has yet gone far enough to allow of lint tests being carried out. The first lint tests are, however, available, on JR.14/5 (Evelyn's Domains Sakel to which H₁ has been transferred from Tanguis) together with its parental Sakel control :

	Effective length.	Standard Count × strength.				
		Hair Wt.	80's	100's	120's	H.S.C.
JR.14/5 ...	49	135	2708	2568	2209	120
Evelyn's Sakel ...	50	127	2779	2515	2302	123

These figures suggest that H_1 can be transferred to Sakel without upsetting lint quality. Since the Tanguis gene H_1 also appears to be the basic gene governing hairiness in MU.8b and St. Ignatius, it is to be hoped that part, if not all, of the excellent hairiness of these types can be transferred to Sakel without affecting lint quality.

2. *Deciduous Bractlet*.—The transference of the gene controlling this character to Sakel and BAR.SP.84 will be discontinued since this season's families have shown that the character cannot be freed from its subsidiary deleterious effects on boll size, boll shedding, leaf abnormality and reduced fertility. These secondary effects of the gene are easily negated by selection, presumably as a result of minor gene modification, but such modification also reduces the main expression of the gene so that the nearer the plant is brought to normality the less the effect of the gene on the bracts. In fact, a fully normal plant can only be produced at the expense of so modifying the expression of the main gene that the bracts cease to be deciduous.

3. *Cluster Characters*.—The transference of "Egyptian short-branch" and of *hirsutum* "Cluster" to Sakel will also be discontinued as a result of this season's work. When fully transferred, these genes were found to have such a weak expression as to be of no economic significance.

4. *Transference of lint Strength from G. thurberi to Sakel*.—Three families were raised this season as a result of hybridization between the three strongest plants in last season's plot and BAR.14/7. The composition of these families was (*G. "thurbadense"* × Domains Sakel³) × BAR.14/7 F_1 . All suffered a crippling attack of leafcurl, but a small quantity of self-bred seed was obtained from most of the plants, and several were selected which appeared to carry the *thurberi* strength. The best of these plants have been crossed with BLR.14/16 to introduce leafcurl resistance, and their lint is being sent to the Shirley Institute for test.

As pointed out in my last season's report this work has two possible uses. Firstly it offers a means of increasing the strength of Sakel by some 22 or 23%. Secondly, in jassid resistance breeding, should the addition of leaf hairs increase the fibre hair-weight, this material with standard hair-weights of 104–107 would be useful for again reducing it.

5. *Wild Gossypium accessions*.—Seed of *G. anomalum* was sent in from Semeiha on the Abu Hahl Scheme in Kordofan Province, where it was growing on goz land near to the cultivated cotton area. Another accession was received from Gibril (12°50'N, 28°13'E) 17 miles N.W. of Nahud where it was found on the flat plain of a small *khov*.

DISEASES AND PESTS.

Blackarm (*Xanthomonas malvacearum*) was, as usual, general during the rains.

Leafcurl was again exceptionally severe, more so even than last season.

The control of pink and Egyptian bollworm by spraying with Gammexane and D.D.T. seemed ineffective this season. Towards the end of the season an arsenical spray was substituted and appeared to reduce the amount of damage.

PUBLICATIONS.

- KNIGHT, R. L. & BOYNS, B. M. 1950. Agricultural Science in the Sudan : A Bibliography to 1948, with selected Abstracts.
- KNIGHT, R. L. & HUTCHINSON, J. B. 1950. The evolution of blackarm resistance in cotton. J. Genet. (In press).
- KNIGHT, R. L. 1950. The genetics of blackarm resistance, VIII *Gossypium barbadense*. J. Genet. (In press).
- HUTCHINSON, J. B. & KNIGHT, R. L. 1950. Response of cotton to leafcurl disease. J. Genet. (In press).

SUMMARY AND CONCLUSIONS.

The production of a Domains Sakel type resistant to blackarm is complete as regards the gene B_2 , and the product, BAR.14/7, will be used to sow the whole 650 acres of Gondal Scheme next season and also some 350 acres in the Gezira.

Straight selection within this type has yielded a leafcurl and blackarm resistant strain of which one acre was grown this season under the number BLR.14/16. The addition of B_3 to BLR.14/16 is proceeding.

In breeding for jassid resistance all crossing was switched to BLR.14/16 as the backcross parent (in place of Domains Sakel and BAR.14/7). It has been shown that the full hairiness of several *G. hirsutum* types is transferable by a process of backcrossing alternating with selfing. This work has been greatly handicapped by two seasons of severe leafcurl. Now that BLR.14/16 is available as a backcross parent the position will rapidly improve.

Of twenty Upland strains imported from the American Cotton Belt, none carried any worth-while blackarm resistance.

In the transference of lint strength from *G. thurberi* to Sakel the third backcross of the hexaploid *G. "thurbadense"* with Sakel was grown. This suffered an extremely heavy leafcurl attack but enough lint was produced for a preliminary examination and several plants were selected which appeared to carry the extra strength.

PROGRAMME FOR 1948-49.

All the lines of work shown in this report will be continued except where otherwise indicated.

KADUGLI STATION

BY

M. F. ROSE.

METEOROLOGY.

From the point of view of field experimentation the season was bad, probably the worst on record ; this can be ascribed directly to an exceptionally low rainfall, badly distributed.

Rains broke normally in mid-April, but by the end of June only 137 mm. were recorded, less than half the rainfall recorded for the same period in the 1947 season. Where abundant seed of miscellaneous crops was available, advantage was taken of fair planting conditions in mid-June, but it soon became apparent that all such plantings would have to be resown owing to the lack of following rains. Drought conditions were broken, however, on July 2nd by a precipitation of 62 mm., the first good rain of the season. It was imagined that the true *khari*f had commenced, and all breeding material (cotton and dura) and main experiments were sown on this rain. Drought conditions followed and from the middle of July it was necessary to save the cotton breeding plot by hand watering. From July 15th to August 30th 8 tons of water were carted and applied to the single plants on every third day, no small strain on the resources of the staff with its fluctuating supply of casual labour. Such conditions persisted until the end of August, when a timely 42 mm. saved the situation. Thus the crop was allowed neither to establish itself nor develop.

September rains were good and above average, but these had little effect on plants already stunted and desiccated by two months' drought. In the middle of October the crop showed marked drought effect (owing to lack of reserve moisture in the soil) and by the end of the month most of the top crop had been shed. There was much premature opening and both the quality and quantity of the crop was well below average. Bulk G.O.T's were, on the average, down 2.5%.

Relevant data for Kadugli and the Jebels area are presented in Tables I and IA. It will be noted that the seasonal rainfall for Kadugli was 215 mm. below average and only 31 mm. above the record low of 508 mm. in 1937.

TABLE 1. RAINFALL (MM.).

	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Total.
Kadugli 1910-47	2	1	15	79	124	152	156	137	82	6	754
Kadugli 1948 ...	—	—	9	40	85	114	87	174	30	—	539
Dilling ...	—	—	1	97	110	177	134	108	7	—	634
Lagowa ...	—	—	—	133	53	40	159	75	9	—	469
Talodi ...	—	—	38	23	155	117	103	244	86	3	769
Kalogi ...	—	—	42	110	210	153	129	174	34	5	857
Abu Gebeiha ...	—	—	—	37	71	96	100	135	15	7	461
Umm Berembeita	—	—	—	75	47	228	233	89	8	—	680

TABLE 1A. TEMPERATURES (°F.).

KADUGLI 1947 AND 1948.

	<i>Mean Maximum.</i>	<i>Range.</i>	<i>Mean Minimum.</i>	<i>Range.</i>
Period Resting Dec.-May, 1947 ...	99	108-69	67	82-56
" " " " 1948 ...	97	109-76	66	82-53
Period Growth June-Nov., 1947 ...	92	102-75	68	77-56
" " " " 1948 ...	90	103-73	67	76-56

COMMERCIAL COTTON.

With a guaranteed minimum price of P.T. 110 per kantar* for grade I seed cotton, the demand for seed was great. BAR.SP.84 seed (ex Kalogi) was distributed to the whole of the Eastern and Western Jebels (15,644 kantars) with the exception of Lagowa, which received strains NT.96/40, NT.58/43 and NT.205/43 (2,600 kantars). Owing to the shortage of BAR.SP.84 seed in the general changeover from Pump Scheme Strain, Lagowa could not be served but this will be remedied in the 1949-50 season when the whole of the Nuba Mountains will be under BAR.SP.84.

Much abandoned land was brought under cultivation and in many cases where labour was scarce cotton was grown at the expense of the dura acreage. Estimated areas and returns are given in Table II, but yields must be regarded in the light of the present season with its extremely local and erratic rainfall. Thus Umm Berembeita had only 300 mm. on the growing crop while Lagowa, with 24 rainless days in July, could boast of only 40 mm. in that important month. All returns have been considerably reduced since the November assessment: with the very poor rainfall in October, quality must perforce be down.

TABLE II.

	<i>Estimated Area (Feddans).</i>	<i>Yields (Kantars).</i>	
Dilling	9,000	10,000	Total 202,000
Kadugli	15,700	66,000	
Lagowa	8,000	30,000	
Talodi	11,400	40,000	
Kalogi	7,000	25,000	
Abu Gebeiha	8,000	23,000	
Umm Berembeita	8,000	8,000	

Mean = 3.0 kantars per feddan.

GENETICS AND BREEDING.

The breeding plot, planted on July 2nd, comprised the following five distinct groups:—

1. BAR.SP.84, 105 progeny rows for "type improvement" and 15 for "type maintenance."

2. Nyasaland types, 9 progeny rows from C.L. 20-4 and 7 from Mz.561.

*100 P.T. = £1; 1 Kantar = 99 lb.

3. Wilds II, 23 progeny rows.
4. U.4/8161 $\times$ M.U.8, special bulks A332, A449 and A455*.
5. U.4/5143 $\times$ Cambodia, special bulks A2106, A220 and A292*.

Excellent stands were obtained in all groups, but it soon became apparent that previous drought conditions and the lack of an adequate moisture reserve would adversely affect plant development. On August 22nd, at the commencement of flowering, average plant height was only 35 cms. : profile pits dug over the area indicated that the rains had penetrated to a depth of 18 cms. and that there had been no effective link-up with sub-soil moisture. Sowing commenced on August 28th and, in order to save as much seed as possible, any plant which looked like surviving and giving some return was taken : rain on August 31st saved the situation and allowed single plant selection to be made. Final returns of seed cotton per plant were very low but sufficient to allow of the routine laboratory analyses.

Group 1.—For earliness and all round performance BAR.SP.84 derivatives showed up well. Types far superior to the commercial bulk have been sorted out and these will be tested in small scale trials in the near future. One feature only in the make-up of the commercial crop is open to criticism, its maturity is down compared with that of its predecessor, Pump Scheme, when grown under very poor conditions. There is every indication, however, that this effect can be remedied by selection and in this respect data from spinning tests will be of major interest and importance. Data from the four most promising lines (266, 301, 714 and 723) are given below : their strength and yarn appearance in relation to that of the parental bulk are worthy of note.

TABLE III.

					Lea product (40's).	Yarn Appearance.	
266	ex BAR.SP.84	...	...	...	2456	Mod.	Small scale S.T. Report 159. 1947/48
301		...	...	...	2503	F.G.	
714		...	...	...	2427	G.	
723		...	...	...	2461	G.	
Parental BAR.SP.84	...	...	...	...	2324	F.G.	
P.S.S.	...	...	...	...	2194	F.G.	

Group 2.—Under the conditions of a normal season in which heavy rain is concentrated in the months of July and August, Nyasaland selections have tended to become coarse and woody with profuse vegetative growth. For this reason work since 1945 has been directed to selecting more open, less lush types, at the same time retaining the prolific fruiting capacity, hairiness and lint quality (strength) of the original introductions. The present abnormal season, however, put the necessary check on such development and induced a more normal plant structure. By the end of August this group stood out as the most robust in the breeding plot, and although showing drought effect,

*The six special bulks kindly supplied by C.E.S., Barberton, Transvaal.

came through to give individual plant yields of a high order. There is some resemblance between the present Kadugli season (1948) and the normal season in the eastern rainlands (Gedaref area) and it is worth speculating on the behaviour of such types under such chancy conditions.

From general observations and node counts over the whole group it is apparent that Mz.561 derivatives are earlier than those from CL.20-4: for this season more attention will be paid to the former sub-group.

Group 3.—The Zeidab quality types selected primarily for earliness in 1947 from Wilds 11 (the commercial N type of the Sudan) did not seem unduly affected by the change of conditions from an irrigated to a dry-land crop. Considering the drought, initial growth was fair but it soon became apparent that jassids were having a retarding influence on subsequent plant development. This continued until harvest time when all lots showed typical leaf scorch: final yields were markedly reduced by jassid damage, a fact directly related to the glabrous character of the plant: plant appearance from mid-season onward was a sharp reminder of the presence of jassids in the Nuba Mountains area and of the necessity to maintain the requisite standard of hairiness (both length and density) in the commercial crop.

From the 23 lots on hand an attempt will be made to select and fix early-maturing types. Under Zeidab conditions pink bollworm and the capsid bug *Creontiades* take a fair toll from the early mid-season crop: with an earlier maturing type such loss and damage might well be shifted to the later pickings with a consequent increase in final yield and improvement in overall grade. If earlier types be evolved, lint quality will have to be re-examined under the normal Zeidab conditions of irrigation.

Groups 4 & 5.—The two groups are contrasted in Table IV and the following generalizations can be made from yield observations. Under the abnormal conditions of season the three Cambodia types A.2106, A.220 and A.292 were definitely more sturdy and robust than their M.U.8 counterparts: they were later and carried a heavier crop, with A.220 heading the yield figures in seed cotton. Opening in all six lots was good and clean with the M.U.8 derivatives yielding a higher percentage of their total crop in the earlier pickings: the group as a whole was stronger and more vigorous than the BAR.SP.84 selections but less so than the Nyasaland lots (Group 2).

Attention will be centred on the M.U.8 derivatives not only because of their relative earliness but also because of their high maturity ratios (especially A.455) under Barberton conditions. It remains to be seen whether this standard can be maintained under the short growing season (5 months) of the Kadugli area. It must be pointed out, however, that none of these types can approach the re-selected BAR.SP.84 material in earliness.

TABLE IV.

Strain.	Mean Blackarm Grade	Mean Node No.	G.O.T.* Power saw	Lint Index gms.	Seed Wt. gms.	Mean Maximum Length (mm.)	Yield per acre S/C lb.
A.2106	6.7	8.0	31.0	6.5	12.0	35.4	1517
A.220	6.2	7.8	30.3	6.9	13.4	36.6	1601
A.292	6.3	7.9	31.7	6.1	12.0	35.7	1247
A.332	6.5	7.5	32.0	7.1	13.5	36.2	1544
A.449	6.0	7.6	31.6	7.5	14.1	36.3	1163
A.455	5.4	7.2	32.7	6.3	12.0	36.0	1095

*All G.O.T's. down 2.5% on average.

EXPERIMENTAL RESULTS.

3⁴ Factor Experiment.—This experiment of 81 plots (9 blocks $\times$ 9 treatments) follows directly from the spacing experiments initiated in 1946. Fortunately the trial was sited on the most low-lying block on the Kamina Farm; otherwise it would have shared the same fate as that of subsidiary experiments.

The treatments were :—

1. Three levels of increasing earliness : v0 = Pump Scheme Strain, v1 = BAR.NT.96/40, v2 = BAR.SP.84.
2. Three levels of planting date : d0 = 2nd July, d1 = 27th July, d2 = 4th August.
3. Three levels of intra-row spacing s0 = 45 cms., s1 = 60 and s2 = 90 cms.
4. Three levels of plants per hill at final thinning, h0 = 2, h1 = 3, h2 = 4.

The inter-row spacing was constant at 90 cms. Each level of planting date was thinned on two occasions, the first at the 2nd rough-leaf stage, the second at the 5th rough-leaf stage : these thinnings were approximately 15 and 25 days respectively from planting date.

Pickings per sub-plot (0.02 acres) were bulked and whole plots were ginned. Yields of lint per acre (to the nearest pound) for the 12 treatments are shown in Table V. Table VI gives main effect and interaction values.

TABLE V.

LINT PER ACRE (LB.).

Treatment.							Yield.
v0. (P.S.S.)	...	...	...	...	...	...	259
v1. (96/40)	...	...	...	...	...	...	268
v2. (84)	...	...	...	...	...	...	259
d0. (2/7)	...	...	...	...	...	...	417
d1. (27/7)	...	...	...	...	...	...	220
d2. (4/8)	...	...	...	...	...	...	149
s0. (45)	...	...	...	...	...	...	286
s1. (60)	...	...	...	...	...	...	270
s2. (90)	...	...	...	...	...	...	232
h0. (2)	...	...	...	...	...	...	248
h1. (3)	...	...	...	...	...	...	270
h2. (4)	...	...	...	...	...	...	269

Overall G.O.T. BAR.SP.84 = 31.2% ; BAR.NT.96/40 = 30.4% :

P.S.S. = 28.4%.

TABLE VI.
MAIN EFFECTS AND INTERACTIONS. LINT PER ACRE (LB.).

Factor.					Linear Response.	Curvature.	Factors.	Interaction.
V	...	...	...	...	-007.	- 17.0	V.D	- 9.7
D	...	...	...	...	-268.1*	+125.3*	V.S	- 5.5
S	...	...	...	...	- 53.7*	- 22.0	D.H	-24.1
H	...	...	...	...	+ 20.4	- 22.85	S.H	+14.2
Standard Error	...	...	...	...	+12.04	+ 20.8	V.H	+27.0
					*=Significant	*=Significant	D.S	- 5.1
								Standard Error
								+14.7

Date of Planting.—It is apparent from Table VI that under the conditions of the experiment date of planting has had a greater effect on final yield than spacing, spacing than plants per hill and plants per hill than variety. The curvature for D is significant at the 1% level. Such data fully confirm the statement in the Kadugli Report Season 1946-7 that "time of planting is more important than strain under Nuba Mountains conditions".

It can be definitely stated that, in the Kadugli area, given suitable planting conditions, the best and safest time for planting is early July: from mid-July onward yields fall off rapidly as instanced by the very low yields of d1 and d2.

Cotton statistics for the years 1935-9 (1) show the Nuba Mountain crop to average only 1 kantar (315 lb.) of seed cotton per acre. Such very poor yields may well be determined by late planting which in itself is intimately connected with the practice of mid-season and late "harig" (2). Good vigorous crops can be grown on early "harig" which would indicate that harig cultivation *per se* is not directly responsible for the marked lowering of yields. The leaching of available nitrogen from the soil by the early rains might well condition the poor development of a late planted crop.

Spacing.—For the 3rd consecutive season the 45 cms. spacing (286 lb. lint p.a.) showed a significant increase over the 90 cms. (232 lb. lint p.a.). The seasons in question offer a fair sample of the fluctuating conditions in the area and the effect of season on spacing is shown below:—

Season.					Type.	Lint 45/lint 90 cms.
1946	...	...	...	...	V. Good	1.43
1947	...	...	...	...	F. Good	1.18
1948	...	...	...	...	Bad	1.23

It will be noted that the 45 cms. spacing has given consistently higher yields despite the type of season. Complete spinning test data from spacing experiments to cover 4 years will be available at the end of the 1949 season: to date there is no evidence that the closer spacing has had a harmful effect on yarn strength or appearance.

Interactions :—Although no interaction is statistically significant at the 5% level, certain trends are shown by the high values of D.H. and V.H. Two 3×3 tables are presented and the practical implications drawn therefrom are discussed.

TABLE VII.
LINT PER ACRE (LB.).

	d0	d1	d2	M		v0	v1	v2	M
h0	380.2	213.0	151.4	248.2	h0	254.2	262.4	228.2	248.2
h1	444.2	220.0	145.4	269.8	h1	265.4	281.0	263.4	269.8
h2	427.2	228.4	150.4	268.7	h2	258.8	260.4	286.6	268.7
M	417.2	220.4	149.1	786.7	M	259.5	267.9	259.3	786.7

$$D.H. = \frac{1}{2} (d2 - d0) (h2 - h0) = - 24.0.$$

$$V.H. = \frac{1}{2} (v2 - v0) (h2 - h0) = + 27.0.$$

On poor land and in late plantings it is customary for the cultivator at thinning time to leave a larger number of plants per hole: the D.H. table would indicate that whereas some benefit may accrue from such a practice in early plantings, no such advantage can be expected in the late plantings.

Plant habit and growth is responsible for the large V.H. value: BAR.SP.84 with its neat compact habit can tolerate a higher plant population per hill than the coarser, strong-wooded types P.S.S. and BAR.NT. 96/40. With the acceptance of BAR.SP.84 as the commercial crop in the Nuba area this point should be borne in mind.

The low value for V.D. is also of practical significance. It runs counter to the belief (fondly held) that the ill effect of late planting can be offset by planting an early variety. Early maturing types are required for the Nuba area but for a successful commercial crop these must be planted *early*.

In review, the experiment brings out the importance of good cultural practice: the figures indicate that BAR.SP.84, early planted, close spaced, at three plants per hill (v2, d0, s0, h1) will yield 431 lb. lint per acre: the same variety late planted, widely spaced, at 2 plants per hill (v2, d2, s2, h0) will return only 108 lb. This is a four-fold increase in favour of intelligent husbandry.

PESTS AND DISEASES.

1. *Pests*.—Possibly due to the extreme droughty conditions, the season was remarkably free from pests and diseases. The leaf roller, *Sylepta derogata*, was the only pest which reached epidemic proportions. It appeared on 22nd August, three weeks earlier than usual, and continued in the crop until the end of October: very bad damage was witnessed in outside areas but on the Kamina Farm the pest was controlled by hand-stripping of affected leaves.

From the "squaring" of cotton, bollworms made their appearance in the sequence American, Egyptian, Sudan and pink. Visual assessment would place the damage as slight and below average.

Regarding stainers, the first migrants of *Dysdercus supersticiosus* were found in cotton on the Kamina Farm on October 2nd: owing to the regular hand collection of the bugs, it was impossible to judge the rate of breeding and build-up of a possible infective population. Observations on western outlying areas, however, would indicate that the initial influx and peak populations were well below average, with *supersticiosus* out-numbering *fasciatus*: in the Eastern Jebels this order of dominance was reversed. The local crop was one of the cleanest on record, with true staining negligible.

2. *Diseases*.—Blackarm (*Xanthomonas malvacearum*) was the only disease of note, with an effect most marked on the late plantings of the susceptible Pump Scheme Strain.

Blackarm counts over the whole of the breeding plot on August 11th and 12th indicated an infection (light) of only 3%: Pump Scheme, planted out in separate control plots throughout this area, showed no infection at all. Following the good September rains the situation changed and blackarm soon made its appearance in both resistant and susceptible material: counts on September 29th made in early August plantings (Expt) showed 100% infection of both P.S.S and BAR.SP.84: whereas the former returned a mean blackarm grade of 8.7 with marked stem lesions, the latter demonstrated its resistance with a mean grade of 6.9. Early planted (July 2nd) BAR.SP.84, counted on the same date, returned the low mean grade of 3.7.

The value of the resistant gene B₂ in the commercial crop has been amply demonstrated during the present season.

OTHER CROPS.

Dura.—On July 2nd four early, twelve mid-season and five late types involving 96 single heads were planted out in progeny rows. In spite of bad conditions, emergence was fairly good and later on in the season it was possible to discard by progeny rows. Final yields per head were low with seed weights well below average.

The "head-to-row" method has now become routine practice in an endeavour to maintain the identity of good high-yielding types in the welter of material (3) available in the Nuba Mountains.

Small special bulks of Fanda, Tahas 85, Toto, Karinaka and Birgalli Ahmer (2/3 acres each) were maintained for local seed distribution. The final mean yield of 635 lb. per acre was half that of a normal season.

Lubia Helu (*Vigna Sinensis*).—The abnormally dry season did not assist in the final selection of types resistant to the mosaic disease so commonly found under the local conditions of concentrated rainfall: the susceptible local type (grown as a control) showed little infection and white fly (the suspected vector) appeared in the crop as late as September. Under such conditions it was impossible to whittle down

still further the 8 resistant types and these will be carried forward to next season. Kadugli 12, the last early type remaining from the 1947 season, shared the same fate as its predecessors, for it was killed off by Mylabrid beetles (flower stage) and by *Anoplocnemis curvipes* (pod stage). Two years' experience with early types would indicate that they cannot survive the early swarming of these two pests.

Groundnuts.—Four propagation plots of Barberton, Medani Erect, American Erect and Abu Arbaa were planted on July 15th. All lots established themselves well under difficult conditions but, following the dry October, many plants died through lack of reserve moisture in the soil and stands became very patchy. Final yields were down to a mean figure of 467 lb. undecorticated nuts per acre.

Oil analysis figures from the 6 types grown in the 1947-8 variety trial are now to hand and are given to complete the picture: Barberton 46.38%, Medani Runner 44.81%, Medani Erect 46.53%, American Erect 47.96%, Kadugli Runner 46.33%, Abu Arba 42.28%.

Sesame.—The importance of sesame as an oil crop and one which fits in well with late planting under "harig" conditions has led to the development here of early maturing strains, resistant to the so-called Marad ed Dam disease (*Bacterium sesami*). On the lighter clay loams, groundnuts find a place in the cotton-dura-groundnut rotation but, on the black heavy clays, harvesting conditions preclude their use: on this soil type sesame can be grown to advantage and is an admirable crop for late planting.

The types of sesame grown during the present season were (i) susceptible Red (ii) early resistant White (iii) resistant White bulk. The early resistant White (ii) was derived from the bulked product of the 98 early single plants selected from (iii) at the end of 1947 season. On July 6th this small special bulk was planted out in single rows alternating with two rows of the susceptible Red. On September 2nd, Marad ed Dam appeared in the "Red" rows and in three weeks every plant was carrying the disease: the rows of early resistant White showed marked resistance: these were heavily "rogued" and any doubtful plant removed. From this material 11 single plants—early (93 days), prolific and with steep flowering curves—were selected. These will be planted out as single plants in the 1949-50 season.

The possibility of avoiding the disease by a change of planting date was considered and, using the susceptible Red, an experiment was laid down with three planting dates, July 6th, July 17th and August 4th, replicated five times. All plantings succumbed to the disease with a complete crop failure over the experimental area. Self-sown sesame on field headlands, germinated by early June rains, also showed symptoms of the disease, so it would appear that a change of planting date as an avoidance policy would be to no purpose.

The appearance of this disease in a susceptible crop does not mean a reduction in yield: it means a complete crop failure. Resistant White types developed here will give fair yields under the worst

conditions of infection (*vide* 1947-8 Report) and in doubtful areas the cultivator should be warned against the use of the susceptible Red : a limited amount of the resistant White seed is available for local distribution.

REFERENCES :

- (1) Snow O.W. Imports—Exports. Memorandum 5. Research Division, Wad Medani.
- (2) Anson R.R. E.C.G.C. Progress Report 1943-4.
- (3) Rose M.F. and Yacoub El Sayegh. An Agricultural Key to the Dura Types of the Dilling-Kadugli-Talodi Area. Memorandum 7. Research Division, Wad Medani.

SUMMARY.

(i) A very low rainfall, badly distributed, was directly responsible for the low yields on the Kamina Farm, Kadugli.

(ii) Relevant meteorological data for the chief cotton growing areas have been presented with tables of estimated areas and yields.

(iii) Material in the cotton breeding plot has been described and future policy toward each group defined.

(iv) Full data from a 3⁴ Factor Experiment (Cotton) have been given and practical implications discussed.

(v) Insect pests have been listed and the trend of blackarm infection followed.

(vi) Work in suitable rotation crops (dura, lubia, groundnut and sesame) has been described.

ACKNOWLEDGMENT.

The season was saved from being a complete failure by the determination and persistent efforts of every member of the staff : the Senior Technical Assistant was directly responsible for the saving of the breeding plot by his efficient handling of the watering gangs during the difficult months of July and August.

PROGRAMME FOR 1949-1950.

COTTON.

- (a) *Breeding*.—Type maintenance and improvement of (i) BAR.SP.84, (ii) Nyasaland types.

Selection for earliness in the quality type Wilds 11 (Progeny lines Z1-Z23).

Observation on the development of the 6 Barberton introductions (U.4 × Cambodia and U.4 × MU.8) with special interest in lint quality.

- (b) *Testing*.—(i) Intra-Varietal : strains 853, 857, 861, 862, 891, (840 + 841) and 836 versus parental BAR.SP.84.

(ii) Miscellaneous : Strains 8121, 8131, 8134 (Nyasaland lots) BAR.NT.205/43 BAR.NT.205/47 versus commercial BAR.SP.84.

- (c) *Cultural*.—3⁴ Expt. :
 3 levels of seed rate per hill (10. 15. 20 seeds).
 3 levels of intra row spacing (45. 60. 90 cms.).
 3 levels of thinning date.
 3 levels of plants per hill (2. 3. 4.).
- (d) *Miscellaneous*.—Progressive deterioration of cotton seed stored under Nuba Mt. conditions (long term).
- (e) *Commercial bulks*.—Isolated areas (3 acres) of (i) BAR.SP.84, (ii) BAR.NT.96/40, (iii) Pump Scheme Strain.

OTHER CROPS.

- Dura*. (a) *Breeding*.—Type maintenance of 4 Early, 15 Mid-season and 5 Late types by the "head-to-row" method.
- (b) *Propagation*.—Commercial bulks of Imsak Maratak, Galb el Jackus (Main Farm) and Fanda, Karinaka, Birgalli Ahmar and Toto (Kamina Farm) for local distribution.
- Lubia helu*.—Small scale propagation of the 7 Kadugli selections resistant to a local mosaic disease.
- Groundnuts*.—Special bulks of Barberton, Medani Erect, American Erect and Abu Arba (3/5 acres each).
- Simsim*.—(i) Eleven single plant selections from Early Resistant White.
- (ii) 1/8 acres of each of the following (a) Susceptible Red (b) Early Resistant White (c) Resistant White Bulk.

APPENDIX.

KEY TO SYMBOLS USED IN THIS REPORT.

Angia.	5 feddan plots are divided into 20 Angia for irrigation purposes.
Asal.	A sticky honey-like secretion found on cotton leaves and sometimes accentuated by aphid or white fly.
B.31.	A blackarm resistant Upland type from Uganda.
BAR.NT.96.	NT.96 carrying B ₂ (American Upland).
BAR.NT.205/43.	Selected from Uganda SP.20. and homozygous for B ₂ .
BAR.SP.84.	The blackarm resistant component of Uganda S.P.84.
BAR.4/5.	9th backcross X.1730 homozygous for B ₂ .
BAR.4/11.	X.1730 carrying both B ₂ and B ₃ .
BAR.7/8.	Blackarm resistant S.P.84 carrying B ₂ and B ₃ .
BAR.14/1.	5th Backcross BAR.2710 × Domains Sakel homozygous for B ₂ .
BAR.14/7.	7th backcross Domains Sakel homozygous for B ₂ .
BAR.14/16.	Selections for leafcurl resistance made from BAR.14/7.
BAR.1730L.	7th Backcross X.1730A homozygous for B ₂ .
BAR.1730L	
Sel. 1 and 2.	.BAR.1730L which has been "filtered."

B.P.52.	A direct import from Uganda.
Cambodia.	American long staple imported from Barberton.
Domains Sakel.	A standard variety originally imported from Egypt.
D.S.1, D.S.2, D.S.3.	Selections and re-selections by Evelyn.
Domains Sakel Sel. 1 and 2.	Domains Sakel which has been " filtered."
Ferguson.	A hairy Upland obtained from the Phillipines via Trinidad.
J.R.14/5.	Evelyn's Domains Sakel to which H ₁ has been transferred from Tanguis.
J.R.1530.	Selection from within 1530 for hairiness.
K.	Large Kantar = 315 rotls.
" L " Cotton.	The X.1530,-X.1730 group of cottons.
Massey's Domains Sakel (M.D.S.).	A Sakel variety selected by R. E. Massey.
M.U.8b.	A hairy Upland from India.
N.T.58/39.	A selection from a " Punjab Early " outcross.
N.T.58/42.	A later selection of the same type as N.T.58/39.
N.T.58/43.	A later selection of the same type as N.T.58/39.
N.T.96/40.	57 × " Over-the-top," a single plant selection.
N.T.205/41.	A selection from Uganda S.P.20.
N.T.205/43.	Successor types to N.T.205/41, above carrying B ₂ .
N.T.205/45.	Successor types to N.T.205/41, above.
Pump Scheme Strain.	Commercial type which originated from Nyasaland Upland.
R.D.S.	Leafcurl resistant Domains Sakel.
" S " Cotton.	Domains Sakel.
S.F.D.-5.	A variety of Domains Sakel originally imported from Egypt.
S.P.20.	A strain imported from Uganda.
S.U.S.7/2.	Blackarm susceptible S.P.84.
Tanguis.	A <i>barbadense</i> type imported from Peru.
Wilds No. 11.	American Long Staple grown commercially at Zeidab. Large balled early.
X.1530.	A bushy variety selected by A. R. Lambert from Sakel.
X.1530A.	A successor type to X.1530.
X.1530 Hairy.	A hairy selection found in X.1530 by H. E. King.
X.1730.	A bushy variety selected by A. R. Lambert from Sakel.
X.1730A.	The successor type to X.1730 at present grown commercially.
1730K.	A reselection of 1730A type.
X.A.G.	X.1730 Gash grown.
X.A.T.	X.1730 Tokar grown.
X.L.	Same as BAR.1730L.
P.S.S.	Pump Scheme Strain.
Harig.	Native name for cultivation following burning off of grasses left from former season.

Genes.

B ₁	A dominant weak blackarm resistant factor from Uganda B.31.
B ₂	A dominant strong blackarm resistant factor from Uganda B.31.
B ₃	A strong partially dominant blackarm resistant factor from <i>punctatum</i> .
B ₄	A strong partially dominant blackarm resistant factor from <i>punctatum</i> .
H	A hairiness factor from Tanguis.
H ₁	A hairiness gene from Tanguis.
H ₂	A hairiness gene from <i>arboreum</i> .

TANGANYIKA TERRITORY.

LAKE PROVINCE.

PROGRESS REPORT FOR THE SEASON 1948-49.

BY

J. E. PEAT.

COTTON, UKIRIGURU.

Planting	...	...	...	17th November to 14th December.
Picking	...	...	...	April to August.
Legal Uprooting Date	...	...	...	7th September.
Rainfall for the Period	1st October	...	...	...
to 30th June	...	...	...	21.77 inches.

Additional Meteorological Information.—The rainfall distribution has been by far the most difficult in the 18 years during which Ukiriguru records have been kept. A fairly satisfactory total of 10.44 inches fell in the period October to December, but the rainfall for January was 1.23 inches, for February 1.76 inches, and for March only 0.32 inches. April was good with 7.24 inches, but the rain tailed off at the end of the month, and the May rainfall was only .73 inches.

Staff and Development.—Mr. A. N. Prentice, after having spent nearly ten years in Sukumaland, transferred to Namulonge in April. He had worked during eight seasons at Lubaga, and two seasons at Ukiriguru. His services, and the experience that he was able to contribute, have been of the greatest value. He has been succeeded by Mr. J. M. Munro, who arrived in January from Barberton.

Mr. H. Doggett, Botanist, Department of Agriculture, in addition to his other activities, has developed the food crop work which was kept going by the Corporation staff during the war years. It is a great pleasure to see this work being carried out on a more adequate scale once again.

Mr. J. F. Tregarthen, Agricultural Assistant, Ukiriguru, went on leave in March, 1949, and was succeeded by another Agricultural Assistant, Mr. P. Long. The services rendered by both these officers have been very greatly appreciated.

Mr. J. Colston, Agricultural Assistant, Shinyanga district, has again devoted part of his time to supervising the experimental programme at Lubaga; the smooth running of the arrangement by which the experimental work at Lubaga continues is largely due to his interest and assistance.

A tribute must be paid to the excellent services of Mr. Shabani Mnuagh, the senior African recorder.

The development of the Ukiriguru station continues. The building programme, which is being carried out by the Public Works Department, has been concentrated during the past year mainly on the Instructors' Training Centre, which is now nearing completion. It is hoped that the construction of the laboratory, ginnery, stores and the completion of the labour quarters will be undertaken shortly.

A Lake Province Cotton Committee, advisory to the Director of Agriculture, met in June, 1949. A Lake Province Cotton Board is to be set up. European staff is awaited ; initial African staff has been recruited ; and mechanical equipment has been ordered. Apart from some stimulus to increased tie-ridging, and in some areas to the use of manure, the steps proposed can have little influence on the 1949-50 crop. But it is hoped, with the setting up of the Board, that their activities will begin to influence the 1950-51 crop. The 1948-49 cotton acreage was reported to be markedly above normal ; but the present serious food shortages, consequent on the bad drought, must restrict and delay cotton plantings for 1949-50 in most areas. This must reduce the 1950 crop.

INTRODUCTION AND SUMMARY.

This has been by far the worst season in the eighteen years during which records have been kept in Ukiriguru. Yet for the experimental work it has been one of the most interesting and valuable ; and for the province it has been a season when the value of cotton in difficult droughty years has once again shown up very clearly. The acreage planted to cotton was recorded as considerably greater than in previous years, because of the attractive price. Immediately around the Lake shore, especially to the west, and on the island of Ukerewe, the drought was less severe. But allowing for all this, a production of around 37,000 bales for the season, when the grain crops were so hardly hit, is another reminder of what the cotton plant can stand. It can suffer in a drought period, as in January, February and March, and then, with April rains, put on a fresh crop to be picked in July and August. Unfortunately the grain crops cannot recover in this way.

The crop from the island of Ukerewe was a record one, not far short of 8,000 bales. Cotton is grown there most successfully, but the balance in land usage is upset by too great an acreage planted to cotton. At the other extreme, because of very serious drought, the crop from Shinyanga district was only just over 800 bales.

On Ukiriguru the yields might be said to have been about two thirds of those of a good season. Even on Lubaga, the sub-station in the Shinyanga district, with good cultivation methods more than half the normal cotton yields were obtained.

The multiplication of UK.46 and UK.48 proceed. UK.46 seed for planting in 1949-50 amounts to somewhat over 1,000 tons. It is to be grown in five Mwanza Ginnery zones. UK.48 is being multiplied in a peninsula in Uzinza, and on Kome Island.

SUMMARY OF THE MAIN EXPERIMENTAL RESULTS.

With bulrush millet as the crop, residual responses were measured at Ukiriguru in two resting crop trials in their fifth cropping year, but the responses in two other trials in their third cropping year were not significant.

Cotton, in the first cropping year, after a planted grass-legume fallow of three years' duration, showed a 31% yield increase over the control, namely, continuous unmanured cropping; but there was a yield decrease following a tumbledown fallow (natural regeneration). In the same trial a dressing of compost at three tons per acre gave an increase of 64%, while a dressing of 300 lb. single superphosphate gave a 71% increase. These are striking responses.

Good fourth year residual manurial results were obtained on a cotton crop, the highest being an increase of 36% over the control from a seven tons per acre dressing of farm yard manure applied five seasons previously. There was a similar residual response from cotton seed ash, also applied five seasons previously.

The indications are that phosphate is probably the nutrient mainly concerned in these residual manurial responses at Ukiriguru.

In a season when jassid attack and bacterial blight were unimportant, UK.48, and the constituent strains and sub-strains from them, showed on the whole satisfactory increases in yield over Mz.561.

The selection and testing work continue—an important part of the cotton work of the station.

GENERAL ACCOUNT OF THE WORK FOR THE SEASON
1948-49.

HUSBANDRY.

Land Resting.—The four simple resting crop trials at Ukiriguru referred to in previous reports were cropped to bulrush millet. Two are now in their fifth cropping year, after three years under rest treatment. Earlier residual results from these trials have not been straightforward.

TABLE 1.

UKIRIGURU—HILL SAND.

<i>Treatments during the three years' resting cycle.</i>		<i>Fifth year of cropping, 1948-49 : indicator crop—bulrush millet.</i>	
1941-42 to 1943-44.		<i>Yields lb. millet per acre.</i>	
		<i>Trial A.</i>	<i>Trial B.</i>
		Control=100	
1. Control :			
continuous bulrush millet	...	410 = 100	460 = 100
2. Continuous bulrush millet—manured for the 1944-45 season	...		
5 tons per acre F.Y.M.	...	476 = 116	— = —
3. Elephant Grass rest, grazed prior to digging in...	...	488 = 119	613 = 133
4. Elephant Grass rest not grazed—manured for the 1944-45	...		
season at digging in, 5 tons per acre F.Y.M.	...	612 = 149	— = —

It will be seen from Table 1 that the residual effects of the Elephant Grass rest and of manuring, and particularly the combination of the two, showed up very well in Trial A. The grass rest responses in this trial have shown up in previous years when bulrush millet has been the indicator crop, but they have not shown with the two cotton crops.

In Trial B the Elephant Grass rest plots, dug-in five seasons previously, showed a 33% increase over control. Lesser benefits were obtained from *Hyparrhenia* and Giant *Cynodon* rests. In this trial benefits have shown every year, whether bulrush millet or cotton is the crop in the rotation.

Two trials were in their third cropping year after three years under resting treatments. The controls (continuous unmanured cropping) were yielding at 530 lb. and 585 lb. bulrush millet per acre. Small increases over the controls, in this the third cropping year, showed in two Elephant Grass and Pigeon Pea rest plots, but none was significant. There was no benefit in the plots which had grown cassava in the resting period, plots which had showed increases in the first and second years of the cropping cycle.

There is a lack of agreement about these results. Evidence from the further range of experiments in progress must be awaited before attempting to explain what is happening. It is evident that, on the Ukiriguru hill soils, a grass rest, such as the Elephant Grass rest in these experiments, when dug-in, increases productivity very definitely the first year if managed reasonably and there can be also considerable residual benefits.

A trial designed to compare methods of land treatment was established in 1945-46. Details of the treatments and the results obtained in the first cropping season are given in Table 2.

TABLE 2.

UKIRIGURU—HILL SAND.

Treatments during the three years' resting cycle. 1945-46 to 1947-48.	First year of the cropping cycle, 1948-49: indicator crop—cotton.	
	Yields lb. seed-cotton per acre.	Control = 100.
A. Cropped during the resting cycle.		
1. Control: continuous bulrush millet, undersown with food legumes	538	= 100
2. Continuous bulrush millet, undersown with food legumes—dressed three tons per acre compost for the 1948-49 season (previously dressed three tons per acre compost at establishment of experiment, 1945-46)... ..	883	= 164
3. Continuous bulrush millet, undersown with food legumes—dressed 300 lb. single superphosphate per acre for the 1948-49 season (previously dressed 400 lb. per acre raw rock phosphate at establishment of experiment, 1945-46)	922	= 171
B. Resting Treatments.		
4. Three years' planted grass fallow, undersown <i>Tephrosia</i> and <i>Crotalaria</i> —grazed	707	= 131
5. Three years' tumbledown fallow—grazed	462	= 86

With cotton as the first crop in the cropping cycle, the yield increase over control after the planted fallow treatment was 31%. (Half-way through the picking period the increase was 19%; and

prior to the last picking it was 44%). The tumbledown fallow finished 14% poorer than control. (Half-way through the picking period the tumbledown fallow yields were 40% poorer than control.) Plants were stunted compared with the other treatments, and stands were poorer. There was a considerable cover of *Tridax repens* compared with the other plots, and this persisted through the season even after hoeing. *Tridax* was the predominant cover during the tumbledown fallow period, and there must have been a substantial accumulation of seed in the soil. There can thus be difficulties, that were not foreseen, in recommending a period of tumbledown rest for the exhausted hill lands.

In dry seasons, on the Ukiriguru hill sands the grass ley is difficult to establish, and growth is poor where the land is exhausted and has not been manured; yet it is this land that it is desired to improve by such ley rests.

In a new resting trial, established this season on poor land, the grass-legume cover has been very poor indeed, and there has been miserable growth through the dry season.

Blocks of *Panicum maximum*, *Cenchrus ciliaris* and *Brachiaria brizantha*, which had been down for four seasons, grazed at the end of each season, were grazed to the ground through the 1948 dry season. But on ridging a considerable mass of roots had to be incorporated into the ridges. Early cotton growth on these plots was good, but plants wilted badly and suffered in the dry months, much more so than in areas continuously cropped and manured. Such an effect in a dry year after incorporating a grass cover is another aspect that needs consideration.

At Lubaga, most unfortunately, the third year of cropping on the black loam, comparing cropping after grass rest with continuous cropping, gave no information, because of bad groundnut stands and partial crop failure. In the previous year, the second cropping year of the cycle, there had been a 20% increase in stalk weights, and a 9% increase in grain as a result of the grass rest.

In two district plots, on fairly heavy soils, happier growth was observed this season, following a grass rest, compared with the portions of the areas where there had been continuous cropping. Some soil structure tests, very kindly carried out by Dr. G. ap Griffith, Senior Chemist, Uganda, on samples from a district plot at Mabuki, and from Lubaga, both heavy soils, showed a building up of structure from the grass rest, and a falling away on cropping.

Contrasted with the grass at Ukiriguru this past season, the growth of *Cenchrus ciliaris* at Lubaga, and at Butulwa near Lubaga, was very good, and especially so contrasted with the country around. But at the time of writing, December, after the first rains since April, the quick get away of Prentice's *Cenchrus ciliaris* selections grown at Ukiriguru, is impressive.

Manuring and Fertilisers.—Probably the most important results of the season have been the Ukiriguru manurial responses, direct and residual, and the suggested linking-up of these results with the responses obtained from phosphate applications. It would look now as though much of the residual manurial benefit, which previously could not be understood, might primarily be due to phosphate, and the carry over somehow in the soil of organic phosphate. It may be that the phosphate responses, possibly in stimulating root development, have shown up more markedly in this type of season.

At the same time it is necessary to appreciate the differing responses on different soil types. It would be a mistake to generalise. On the hill sand soils there are marked benefits from manuring, and there is the present suggestion that the responses are possibly mainly phosphate responses. The benefits from the grass rest are somewhat confused. On the heavier soils in the province there is not the same benefit from manuring and probably not from fertilising. But on these soils, more work is needed on the structure building value of the grass rest, and on the extent to which such a rest might be essential or not if tie-ridging is practised.

In the trial already mentioned, Table 2A, the two cropping variants, over and above the control cropping, are treated at the start of each cycle, i.e., at the start of every three year period. In 1945-46 the fallow rests were started, and the first treatments applied. In this past season the first cropping cycle started with cotton as the indicator crop; the manured plots received three tons per acre compost, and the phosphate plots 300 lb. per acre single superphosphate. (The 1945-46 phosphate dressing had been 400 lb. per acre raw rock phosphate; responses to this had been small). The phosphate plots showed an increase of 71%, and the compost plots an increase of 64%. These are very striking increases. The control plots picked up on the last picking—the picking period was protracted because of the second crop flush brought on by the April rains, following the January-February-March drought. (At the fifth picking, the phosphate plots were 91% up on control, and the compost plots 81% up.) This is the first season that superphosphate has been used. Earlier views on the value of phosphate applications were based on the use of Kenya soda-phosphate and raw rock phosphate. In the 1949-50 experiments single and triple superphosphate are being used.

An N.P.K. Compost trial 3⁴ was laid down, but unfortunately the only uniform land available was in reasonably good heart. It had been under Elephant Grass rest until 1946, manured at digging in; but prior to laying down this trial two crops had been taken off—a cotton crop and a maize crop. The results are shown in Table 3.

The response on the F.Y.M. seven tons per acre plots was a mean increase of 36%. The plots that had had the heavy dressing of cotton-seed ash—1½ tons per acre—showed a benefit of only 6% before the later pickings, but finished with an increased yield of 33%. (In last season's report it was stated that with a crop of bulrush millet there had been no benefit from the residual effects of the cotton-seed ash and that the effects had disappeared in the fourth year.)

The phosphate responses at different stages of the crop were interesting. The superphosphate plots in the trial, the results of which are set out in Table 2 (dressing 300 lb. single superphosphate per acre), and the cotton-seed ash plots (fifth year after application), mentioned above, could be picked out from the middle of the season onwards; growth was distinctive, and there was a lighter green leaf colour.

The continuing residual responses from manuring and to a lesser extent from certain resting treatments, are important in their influence on any formulation of plans for land usage and it is interesting to have the effects continuing year after year. But there is a certain embarrassment in the locking up of uniform areas of land for a much longer period of years than was anticipated, when comparatively simple exploratory experiments were first put down. Two resting crop trials are entering into their ninth year, and a simple manurial trial into the sixth year.

Tie-Ridging.—It would be expected that, in a season of poor rains, the benefits from tie-ridging would be marked. This was so. At Ukiriguru in one experiment, cotton on good ridges tied yielded as 183 : 100 compared with poor ridges not tied.

TABLE 5.

UKIRIGURU—HILL SAND.

	Cotton.		Millet.	
	Yields lb. seed-cotton per acre.		Yields lb. millet per acre.	
	Control = 100			
Poor ridges—not tied	320	= 100	90	= 100
Good ridges—tied	583	= 183	304	= 338

In this experiment, in its third year, there may now be possibly some cumulative effects with a three years' loss of the finer soil particles in the non-tied plots. The same plots are used each year; there is no manuring. The benefits showed up to the greatest extent in the last picking—i.e., the late crop. Prior to the last picking the total

response from the good ridges tied was + 50%. On the bulrush millet half of the same trial the differences were more striking. With a poor initial bulrush millet stand gaps had to be filled at thinning by transplanting. The yield of bulrush millet on the poor ridges not tied was only at the rate of 90 lb. per acre—to all purposes a failure—and on the good ridges tied 304 lb. per acre, at least a poor yield.

On a bigger trial under cotton, bringing in poor ridging and good ridging, tying and not tying, manuring and not manuring, there were difficulties in this the first year of the trial. No differences in yield showed between the two types of ridging made; tied to not tied was 131 : 100, and tied manured to not tied unmanured, 160 : 100.

The results of the trial at Lubaga on the hard-pan soil "ibambasi" are given in Table 6. On the sorghum portion of the trial the contrast was very striking.

TABLE 6.

LUBAGA—HARD-PAN SOIL (IBAMBASI).

	Cotton.	Sorghum.
	Yields lb. seed-cotton per acre. Control = 100.	Yields lb. sorghum per acre.
Flat cultivation—3ft. rows	305 = 100	137 = 100
3ft. ridges—tied	406 = 133	362 = 264
4ft. ridges—tied	460 = 151	444 = 324

COTTON BREEDING.

Though Ukiriguru cotton yields were lower than in most years the trial results and the yield levels were satisfactory for the year. Jassid was unimportant, though a small amount of damage could be noticed on "Local" at the end of the season. Bacterial blight (*Xanthomonas malvacearum*) was quite unimportant. There was in parts of the station a small American bollworm loss. Much of the selection effort has been directed towards getting strains having good jassid resistance, together with the other qualities needed, and more lately an attempt to get, in addition to these qualities, resistance to bacterial blight. The trial results of this season on Ukiriguru, and in general at Lubaga and on the district plots, show increases when neither jassid loss nor bacterial blight were yield reducing influences.

Results from two Ukiriguru trials, and a Lubaga trial, are given in Table 7. The ginning percentages used were from the hill trial samples through a small gin. The full comparison of ginning percentages at various centres has not yet been completed.

TABLE 7.

MAIN RESULTS OF BALANCED LATTICE TRIALS.

Adjusted yields in lb. per acre. Figures in brackets show lint yields as a percentage of control, MZ.561.

Strain.	Ginning. %	Ukigiruru.				Lubaga.	
		Hill Soil.		Valley Bottom. "Mbuga"		Black Loam "Ibushi"	
		S/Cotton	Lint	S/Cotton	Lint	S/Cotton	Lint
MZ. 561	31.8	1106	352 (100)	721	229 (100)	454	145 (100)
UK.46	33.6	1138	382 (108)	808	272 (119)	493	167 (115)
UK.48	33.8	1100	372 (106)	824	278 (121)	561	190 (131)
A.2106	35.6	1195	425 (121)	781	278 (121)	559	199 (137)
MU.8	34.0	1115	379 (108)	745	253 (110)	662	225 (155)
<i>UK.48 Constituents</i>							
5/57	35.1	1209	425 (121)	694	244 (106)	505	177 (122)
Range of 5 Derivatives of 5/57	34.3 to 36.0	1187 to 1238	407 (116) to 439 (125)	713 to 831	245 (107) to 285 (124)	521 to 579	179 (123) to 209 (144)
	36.0	1159	417 (118)	675	243 (106)	506	182 (125)
Range of 4 Derivatives of 6/29	34.0 to 36.0	1115 to 1218	402 (114) to 414 (118)	683 to 746	246 (107) to 253 (110)	438 to 551	158 (109) to 198 (137)
	34.8	1049	366 (104)	724	252 (110)	503	175 (121)
Range of 3 Derivatives of 6/44	33.7 to 34.3	1049 to 1130	360 (102) to 380 (108)	693 to 820	238 (104) to 281 (123)	500 to 522	169 (117) to 179 (123)
	33.0	1170	386 (110)	871	288 (126)	567	187 (129)
Range of 5 Derivatives of 6/318	32.0 to 33.2	1223 to 1280	392 (111) to 425 (121)	718 to 846	230 (100) to 278 (121)	523 to 668	167 (115) to 222 (153)
<i>Derivatives L4/112</i>							
7/363	33.2	1092	363 (103)	649	216 (94)	540	179 (124)
7/367	33.0	1175	388 (110)	653	215 (94)	625	206 (142)
Significant Diff. P = .05 ...	—	114	39 (12)	122	41 (18)	84	29 (20)

In the second Ukigiruru strain trial on the valley bottom black soil, "mbuga", growth was poor and yields were lower than on the hill. The showers during the January-February-March drought, that just kept the hill cotton going, were of no benefit on the heavy soil; much of the crop was made after the April rains.

At Lubaga, as often happens there, especially in a difficult year, increases over Mz.561, were greater than at Ukigiruru. MU.8, though not significantly better than Mz.561 at Ukigiruru in either trial, at Lubaga was the top yielder. In the same way, the L.4/112 lots, ex a Lubaga selection, do better there than at Ukigiruru. This differential response on two stations in one province is important to note.

The best district plot, again at Arugongo in Uzinza, gave, in the strain trial there, the magnificent average yield for the season of 2,000 lb. seed-cotton per acre for the thirty strains—UK.48, the four constituent strains, and twenty-five daughter sub-strains. This was on good land in the first cropping year after a three years' tumbledown grass rest. (cf. the Ukigiruru results following a tumbledown rest on

exhausted land.) Mz.561 yielded 1,465 lb. seed-cotton per acre. The best Ukerewe Island plot was yielding around 1,200 lb. per acre for the same thirty strains, with Mz.561 yielding 790 lb. seed-cotton per acre: UK.46 yield was intermediate. Yields in most of the other district plots were considerably lower, running from about 400 lb.—600 lb. seed-cotton per acre, and with varying strain comparison results. Two plots at the South of the province were failures, and another one nearly so.

It is necessary to bear in mind how environment and season can affect lint quality, especially in a difficult season. A query was raised through the Senior Botanist, Uganda, by the Chairman of the Cotton Exporters' Group, about the high quality of a sample from Ukerewe Island, entirely superior to the general run of Mwanza cotton. About the same time the Ginnery Inspector, Mwanza, commented on the shortness and harshness of the lint in a ginning test at Shinyanga. Yet both samples were produced from the same seed stock, Mz.561: but the environments were entirely different.

Material from the 1948-49 trials is to be sent to the Shirley Institute for spinning tests. There is a special interest in any quality differences which might show up—differences in maturity and the amount of nep, which might show more markedly after a difficult year.

A small collection of varieties and types of other than "Local" origin is maintained. Included in this was a small selection of Upland types from the Central American collection, sent by Dr. J. B. Hutchinson.

PESTS AND DISEASES.

Jassid.—On Ukiriguru jassid attack was very light. Only towards the end of the season were the strips of jassid-susceptible "Local," planted between the strain trial replications, showing slight damage.

In Uzinza after the April rain jassid developed, especially on poor land. Where the boundaries of the Mz.561 and UK.46 areas met, the damage on Mz.561 was very evident contrasted with the resistance of UK.46. Towards the end of the season UK.46 there also showed some jassid damage. UK.48 has better resistance.

Stainers.—Stainer damage was mainly light. At Ukiriguru the percentage of Grade C was only around 6% in the hill trial. At Lubaga the percentage of Grade C in the variety trial was 14%, but this trial was treated with sweetened sodium arsenite as a routine treatment. The stainer poisoning trials there gave no results. In the district plots in the Lake shore fringe the amount of Grade C was low, but it was heavier in Maswa district where the crop picked was from late flowering.

Aphis.—*Aphis* affected the cotton during the drought, causing some checking of growth especially in the later planted plots. As usual, when rain did come, plants grew away again.

Lygus.—*Lygus* damage was negligible, as was to be expected in a dry season.

Bacterial Blight (*Xanthomonas malvacearum*).—Little progress could be made in the grading of strains for resistance, though this was attempted. At Ukiriguru spraying with suspension was done early in the season. There was a development of leaf spots, which even in the most resistant strains showed some coalescing and vein infection, but except for some blackarm damage in April in A.2106 in the main Ukiriguru hill trial, blackarm damage was difficult to find. On native shambas, in the early growth, there was some blackarm damage. If bacterial blight was never to be more in evidence than this season resistance to it would not be necessary. Lots of Ukiriguru material, kindly sorted for homozygous B_2 by Dr. J. B. Hutchinson at Shambat, and seed of BAR. 7/8, ($B_2 B_3$), were grown, but the season was such that reasonable comparisons could not be made between this material and the Ukiriguru strains previously graded for resistance.

MISCELLANEOUS.

During the year the writer attended, at the invitation of the Director of Agriculture, as a Tanganyika delegate, the African Regional Scientific Conference in Johannesburg, and an East African Agriculture and Forestry Research Organisation Specialist Committee on Fertilisers.

A paper was published in the October number of the East African Agricultural Journal entitled "The Maintenance of Soil Productivity in Sukumaland and Adjacent Areas, Tanganyika," by J. E. Peat and A. N. Prentice.

PROGRAMME FOR 1949-50.

The 1949-50 programme shows little change from other years, apart from a following up in certain fields of the results of earlier trials. The land resting trials and the manurial and fertiliser trials will continue to measure residual responses. A new N.P. Organic trial has been laid down using triple superphosphate; there will also be trials with cotton and sorghum comparing the re-inforcing of compost with single superphosphate with other ways of applying superphosphate and compost. The soaking of cotton-seed and sorghum in nutrient solutions is also to be tested.

The agronomic experiments will continue, in the main as before, with the addition of a weeding experiment on cotton, and a repetition

of earlier experiments, on splitting and not splitting ridges before planting.

The cotton selection and strain testing work will continue as in previous years. The main material is from the constituents of UK.48. There are to be three balanced lattice trials on Ukiriguru, mainly of 1947 and 1948 single plant material, one under good conditions on the hill, one under poor conditions on the hill, and one on the "mbuga." A similar trial is planted at Lubaga. District plots carry two replications at each centre of a two dimensional lattice.

The grading work for resistance to bacterial blight is to continue.

An attempt will be made to continue at Lubaga the exploratory experiments on stainer poisoning.

APPENDIX.

ORIGIN AND SPECIAL CHARACTERISTICS OF THE MAIN COTTON STRAINS MENTIONED :

- LAKE PROVINCE "LOCAL." The commercial cotton of the province prior to the issue of Mz.561—mainly of Uganda Local Origin.
- Mz.561. A straight selection from "Local," first multiplied in season 1939-40 : now the commercial seed stock of the province.
- UK.46. A seed issue with fair Jassid resistance, first multiplied in the 1946-47 season ; made up of the four best Ukiriguru strains and the three best Lubaga strains, available at that time.
- UK.48. A seed issue made up of four strains, 5/57, 6/29, 6/44, and 6/318, of better Jassid resistance than UK.46, and with some blackarm resistance ; first issued for the 1948-49 season.
- 5/57. A derivative of 3/17, itself a straight selection from "Local."
- 6/29. ex 2/388, itself a derivative of Mz.561.
- 6/44. A derivative of 3/17, itself a straight selection from "Local."
- 6/318. ex 4/35, itself a derivative of Mz.561.
- L4/112. A Lubaga strain, ex Mz.457, which was multiplied in season 1939-40 and then withdrawn.
- A.2106. A Barberton strain, U4 x Cambodia ; now the standard strain in cultivation in the Barberton district.
- MU8. A Malwa Upland strain selected by Dr. J. B. Hutchinson ; the seed was obtained from Barberton.

EASTERN PROVINCE.

PROGRESS REPORT FOR THE SEASON 1948.

BY

A. G. BEBBINGTON.

Planting period	...	...	...	Mid-February to mid-April.
Picking	...	...	...	August to October.
Uprooting	...	...	...	By 15th November.

INTRODUCTION.

The report covers the work on Ilonga station and on six district plots. Two new plots were established in a fertile area south of the Uluguru Mountains to replace those abandoned at Kingolwira Farm and Kingolwira Village.

Mr. H. J. de S. Disney of the Corporation arrived at Ilonga for entomological work in June. Mr. Thomson, Agricultural Assistant, proceeded on leave at the same time and was replaced by Mr. Long, Agricultural Assistant. Mr. Thomson returned to Ilonga in November. Mr. Parke continued building work on the station throughout the year. This included the installation of an engine and pump to provide water from the Ilonga river, and the commencement of construction of a forty thousand gallon reservoir.

Erection of European and African quarters was also started but progress was slow owing to lack of materials and artisans.

A total of approximately 215 acres has now been cleared for experimental purposes at Ilonga. The main problem with regard to this land is to find a method by which sheet erosion can be controlled. Owing to the high silt content the land packs down to a flat surface very quickly under heavy rain and the run-off is very considerable. The contour banks laid down in 1947 have been found to make experimental work both difficult and costly. It is now proposed to use a system of narrow strips of cultivation for 3 years alternating with 3 years of bush fallow. The dominant grass of the area, *Panicum maximum*, re-establishes itself very easily after three years of cultivation, which is an important point in this bush fallow system.

There remains, however, the difficulty as to how to deal with the regrowth after three years, and the method may have to be modified on this account.

WEATHER.

Rains were good in January, but were followed by a drought in February. They were ample during March and April and some showers fell in May.

AGRICULTURE.

Good crops of foodstuffs were obtained throughout the Province. An increased acreage was planted to cotton owing to the higher price ruling, and satisfactory crops were obtained in most areas. Insect pest attack was light on the whole and particularly so in the case of stainer (*Dysdercus spp*). The maize crop on Ilonga was planted rather late but was satisfactory. Cotton yields on the station were good.

Trials.—A fertiliser trial with maize, including two treatments with silicophosphate (at the rates of 200 and 400 lb. per acre), potash and sulphate of ammonia, was undertaken. This was laid down on some of the poorest land on Ilonga which has probably been cultivated continuously by natives for some forty years or more. Poor stands were obtained with the first planting of Kenya Hybrid seed. The whole trial was hoed out and replanted with a quick maturing native maize. The final yields showed no significant response to the two phosphate applications and no interactions. There was however a significant response to nitrogen alone at a dressing of 100 lb. sulphate of ammonia per acre. This was particularly marked in the early stages of the plants in both plantings.

COTTON BREEDING.

Strain trials were laid down at Ilonga and on five of the district plots. Five old strains originally selected from Local (the Eastern Province commercial seed) were included together with 47 S.B., a bulk taken from the 1947 selections, Local and as a standard for yield, MU.8A (the most productive type yet grown in the Eastern Province, although of low quality).

The results of these trials showed that MU.8A was by far the best in yield. Two strains, and in particular 47 S.B., showed themselves to be better in yield than Local by as much as 25 per cent.

In addition 47 S.B. grown in a multiplication plot on an adjoining sisal estate gave a yield of 1,000 lb. seed cotton per acre. This was in spite of a very severe attack by American bollworm (*Heliothis armigera*), and the fact that it was interplanted with sisal which reduced the plant population to four-fifths of normal.

Selection work was continued and a number of heavy yielding types were obtained. A bulk of 48 S.B. was taken from the remainder, which will be tested in 1949. The aim of this selection work remains, as before, to increase yield while maintaining quality.

INSECT PESTS.

The usual routine recording of the incidence of insect pests and plant development was carried out on Ilonga and on the district plots. A census of the mature crop for stainer and bollworm damage was undertaken.

Jassid (*Empoasca spp*).—Apart from a few isolated cases no damage of any importance was caused by this pest.

American bollworm (*Heliothis armigera*).—This pest did not appear in the very serious numbers that it has in past years except on one district plot.

It still however took considerable toll of the crop. Further reference will be made to it under Insecticide Trials.

Pink bollworm (*Platyedra gossypiella*).—This was only recorded in negligible numbers at Ilonga and on four of the district plots late in the season.

The two plots south of the Uluguru mountains present a different picture. Here the uprooting and burning date is one month later than the remainder of the Province. This is due to varying conditions which permit planting over a longer period.

Pink bollworm was present in some numbers in both plots in this area at the beginning of flowering and remained in one plot throughout the season. While not of first importance it does add to the general loss. It would seem desirable that some restriction of planting should be brought about in order that there may be a longer close season.

Spiny bollworm (*Earias* spp).—This was recorded in all plots throughout the period of the crop. Only in two cases were there populations of any importance.

Stainers (*Dysdercus* spp).—The usual four species *D. intermedius*, *D. fasciatus*, *D. nigrofasciatus* and *D. cardinalis* were recorded in cotton. Mr. Disney succeeded in establishing the presence of *D. superstitiosus* in quantity on various wild host plants towards the end of the year in Kilosa district.

D. intermedius was as usual the most important of the four species recorded in cotton. This species has now shown, over a period of years, a continuous migration into the cotton crop during the season. Practically no breeding takes place until the crop is well open.

At Ilonga and on four district plots only medium populations were registered, and the crop generally was of high grade, as much as 72 per cent. being grade I.

The two plots south of the Uluguru mountains, again showed, as in the case of Pink bollworm, consistently high population figures from the beginning of flowering. This was reflected in the final crop, the percentage of Grade I being only 28 per cent.

Calidea spp.—This was absent in most cases and observed only in negligible numbers elsewhere.

Helopeltis spp..—This was recorded from one plot throughout the season and some damage was caused. Elsewhere the occurrence was of no importance.

Capsid (*Lygus* spp).—No damage of any consequence was caused by this pest.

INSECTICIDE TRIALS.

A comprehensive trial was undertaken at Ilonga to determine whether any control of American bollworm and stainers was possible by dusting the plants with DDT and Gammexane.

Four treatments in all were used.

- (i) 5 per cent. DDT in talc. Two treatments at 10-day intervals. The first application was made immediately after the first larvae of American bollworm were seen.
- (ii) A mixture containing 4 per cent. DDT and 0.5 per cent. γ -Benzene hexachloride in talc applied as in (i).
- (iii) So-called "Blanket treatment." The mixture in (ii) applied weekly for as long as was thought necessary. In this case eleven applications were made which was probably too many.
- (iv) Control. Untreated.

There were six replications of each treatment with plots of $\frac{3}{4}$ of an acre in size. The dusts were applied by means of hand guns at approximately 16 lb. per acre. The rate of application varied considerably owing to variation in the walking speed of the operator and in the pressure applied to the blower. Dusting was carried out early in the morning and in the evening to eliminate drift due to the wind as much as possible.

All squares set on 60 plants of each treatment were ticketed and causes of shedding analysed. Open bolls were also examined for damage. No insect counts could be undertaken owing to lack of trained staff.

These records showed the following :—

- (i) The application of the dusts in the two treatments series was premature and could with advantage have been delayed for ten days.
- (ii) The two applications delayed serious shedding due to bollworm for a period of two weeks.
- (iii) Shedding of crop due to bollworm was almost halved in the case of the "blanket" treatment during the critical period of the attack in June.
- (iv) Shedding due to stainer during the peak period of attack in July was much heavier in the "blanket" treatment than in others. This is not understood unless the blanket plots were more attractive to stainer owing to the fact that they were carrying more crop.
- (v) Shedding due to "Other causes" was also much heavier in the "blanket" treatment in July.
- (vi) The crop saved by the "blanket" treatment was that set in May and June. Little further crop in this treatment was set in comparison with the other treatments after the end of June. This may have been due to the fact that the plants were carrying all the crop that they could. The high "Other causes" shedding would suggest that this was the case,
- (vii) No damage to foliage was noted in the blanket plots.

The final yield figures are given in the following table :—

<i>Yield.</i>	<i>Blanket.</i>	<i>DDT & G.</i>	<i>DDT</i>	<i>Control.</i>	<i>Mean.</i>	<i>Sig. Diff.</i>
Lb. seed cotton per acre ...	902	619	394	439	589	313
Per cent. of Mean ...	153	105	67	75	100	53
Lb. lint per acre ...	286	196	125	139	—	—

" Blanket " significantly better than Control and other treatments at $P = 0.05$.

In addition the crop when sorted showed that only 6 per cent. of the " blanket " treatment was Grade III owing to stainer as opposed to 18 per cent. in the Control.

A second trial in simple form was carried out on an estate crop with two treatments only with an interval of fourteen days. The same mixture of DDT and gammexane was used and applied at approximately the same rate (16 lb. per acre) over 27 acres. This trial was under the supervision of the senior African recorder. Unfortunately the owner of the estate refused to allow him to pick individual samples and so no test could be applied to the yield figures.

The yields were :—Treated area. 536 lb. seed cotton per acre ; Untreated 308 lb. seed cotton per acre. In both cases the percentages of Grade III cotton were the same.

SUMMARY.

1. Satisfactory crops of cotton were obtained throughout and the crop was cleaner than usual.
2. Good crops were obtained on Ilonga and the district plots and some promising strains showed up in the selections.
3. An insecticide trial at Ilonga showed that it was possible to reduce very considerably the damage caused by American bollworm by the use of DDT and Gammexane dust.
4. In a N.P.K. trial with maize the effect of nitrogen was significant but no differences were obtained with phosphate and potash.

PROGRAMME FOR 1949.

Further clearing and surveying of land on Ilonga will be carried out.

The testing of strains and selection work will be continued.

Two insecticide trials will be undertaken. One at Ilonga will be designed to test the number of applications necessary for protection at economic rates and one on an adjoining estate to test the effect of different dusts and the minimum number of applications on a commercial scale. Full costings will be kept, together with insect and development records.

NYASALAND.

SEASON 1948-49.

COTTON EXPERIMENT STATION.

INTRODUCTORY NOTE

BY

H. C. DUCKER.

District.	Elevation.	Types of Crop.	Months in which		Legal Close Season.
			Sown.	Harvested.	
Lower River	200-500	{ Semi-summer Winter	Jan.-Feb. Mar.-Apr.	July-Oct. Sept.-Oct.	} Nov.-Dec.
Central Areas, S. Province ...	1,000-2,500	{ Summer Semi-summer	Dec. Jan.	June-Aug. July-Sept.	} Oct.-Nov.
C. Province, S.W. Lake shore and Bwanje Valley	1,560-2,500	Summer	Dec.	May-July	Aug.-Nov.
N. Nyasa, N.W. Lake shore, Karonga	About 1,600	Winter	Mar.-May	Sept.-Dec.	Jan.-Feb.

NOTE.—The cotton areas of the Central Province have now been provided with a legal close season commencing August 1st. The terms summer and winter used above refer to the southern hemisphere.

The hydrological survey of the Lake and Shire River is proceeding but no findings have yet been published.

The small-scale summer cropping experiment with cotton, referred to in the 1947-48 Progress Report (page 101), has been begun at Chiromo with a no-cotton year within the circle of 5 miles radius which has been delimited. In 1949-50 test plots of cotton will be planted at the Makanga Experiment Station, which is the centre point of the circle, and elsewhere.

A further conference with the Portuguese Authorities, to discuss this experiment and the problems of cotton growing in the Lower River area, was held at Chiromo in May, 1949, and was attended by members of the Department of Agriculture and of the Corporation staff. Subsequently the Portuguese representative, Dr. Barbosa, toured the Nyasaland cotton areas of the Southern and Central Provinces and visited the Cotton Experiment Station.

Nyasaland has suffered a season of drought, unequalled in severity since that of 1921-22. The cotton areas have been particularly hard hit, and a heavy fall in production is certain. The Lower River is unlikely to produce more than one third of the total reached last season, the crop in the central areas is negligible in amount, while that of N. Nyasa will be lower than is usual, not only on account of the drought but also because land is required for the production of out-of-season food crops.

Food crops in general have yielded sparsely, and only in a number of highland areas, in particular on the Lilongwe plateau, were the rains good enough to permit high maize yields.

The drought occurred in two spells of hot, sunny weather. The first, during the normal hoeing season in January, intensified the effect of poor planting rains and did most damage to the annual crops. The second followed in March and early April, preventing emergency February plantings of sweet potatoes, cassava and other root crops from growing as they should. Altogether it has been a distressing year, and food is being imported to relieve hunger among the natives.

Government is doing all that is possible to render help to the people and to make sure that all available supplies of food are evenly distributed, and relief works have been begun in the areas most affected by the drought. Unfortunately the Cotton Experiment Station, being situated in one of these areas, has also had to buy food for its labour.

The Station food crops gave very poor returns, and in some fields the harvest did not return the seed which had been sown. Though cotton was affected by delayed germination and faulty stands, it proved our best crop and thoroughly lived up to its reputation for drought resistance. Yields, on the plots where good early stands were obtained, reached last year's levels, and we can feel confident about the adaptability of our varieties.

The difficulties created for Nyasaland by the drought have not been made easier by the continued lack of a railway bridge at Chiromo, but the emergency ferry improvised by the Railway authorities has performed yeoman service, and an excellent start has been made on the new bridge. It is hoped that the latter may be ready for use early in 1950.

The Group Farming Settlement Scheme at Chitala on the western boundary of the Cotton Experiment Station has been begun, and the Fordson tractor and implements supplied for it by the Department of Agriculture have been available for use on the Station. Some sixty acres of land had been ploughed and cultivated up to September, 1949, and some idea has been obtained of power cultivation possibilities and their relation to hand labour. With high local fuel costs, care will have to be taken to avoid extravagant use of power.

The cotton variety CL20, bred at this Station, has not only proved to have excellent agricultural qualities but has also received very good spinning test reports and a good reception from the broker. It appears to be a decided improvement on the present commercial Crown Land Bulk from which it originated, and arrangements have been made for a large-scale commercial trial on a nearby estate this coming year. $2\frac{1}{2}$ tons of seed are available and it is hoped to plant with this some 250 acres of tenant-grown cotton in isolation. In addition a bulk multiplication of the leading sub-strains will be carried out on the Experiment Station and in cotton plots in the Group Farming Settlement Scheme.

There have been several staff changes during the year, Mr. Miller returning from leave in October, 1948, and Mr. Hastie arriving in the following month. Mr. Evelyn, formerly in the Sudan, joined the Nyasaland staff in March, 1949.

DOMIRA BAY STATION.

PROGRESS REPORT, 1948-49.

BY

H. C. DUCKER, W. L. MILLER, S. H. EVELYN AND M. S. HASTIE.

GENERAL SURVEY OF THE SEASON AND OF THE EXPERIMENTAL WORK ; AND CONCLUSIONS.

METEOROLOGY.

The rains began with some small showers in November in a quite normal fashion, and though the planting rains proper did not break till December 22nd this was in no way unusual in the light of past experience. From that date onwards, however, hardly anything went right with the season, the rainfall being both small and badly distributed. The planting rains in December totalled only 2.27 inches and the soil was never really soaked. This was followed by a hot, sunny January with only 1.28 inches of rain, in small falls, the largest of which yielded only 0.36 inches. Seed which failed to germinate in December either rotted in the ground or lay dormant until February when 7.60 inches of rain, fairly well distributed, were received. Crops might still have done fairly well had March rainfall been adequate but only 3.17 inches fell that month, mainly in two storms with very high winds on the 12th-13th March.

The total rainfall, November-May inclusive, was 18.04 inches but it is unlikely that more than half of this was effective for crops. The dams at no time held more than a small surface puddle, and there was little or no accretion to the ground-water supplies.

AGRICULTURE.

General.—At the Station, the planting season opened on the 23rd December, 1948, and all foodcrops were planted by the 28th. Cotton sowing began on the 28th and was completed on the 31st December. This was a late and not very good start to what has proved to be the worst season ever for food crops at the Station. The germination of cotton in the lattice square strain trials, sown on 28th December, was

fairly good, but it was poor in all other sowings and much seed lay dormant until moderately good rains fell in early February. The delayed germination produced poor growth and very late flowering and bolting, and as a consequence the incidence of stainers, *Dysdercus*, spp., was much higher than usual.

Groundnuts are usually considered a drought-resistant crop but climatic conditions were so adverse that yields barely equalled the seed rates.

Maize gave the very poor yield of approximately 400 lb. per acre and the Sorghum grown, a late-maturing variety, suffered severely from the drought.

Labour was decidedly easier to obtain than last season and the amended paying method and attendance bonuses seem to have given fair results. It cannot be said, however, that our labour troubles are at an end since absenteeism is still rife and there is little disposition to do more work for increased pay. The use of a tractor, for the first time, in breaking up resting land and in general preparatory work should do much to offset the shortcomings of our labour.

Maintenance of Fertility.—The long term experiments have been continued according to plan, but once again maize plots hidden by the elephant grass of surrounding resting plots, failed to give any appreciable yield and much theft of cobs again occurred.

The experiment, described previously, in which 3, 4 and 5 year rest periods, under elephant grass, were being compared with land continuously cropped with maize, was tested this season with maize sown in all plots. The results follow :—

MAIZE YIELDS IN LB. OF COBS PER ACRE.

1. Continuous maize (Control)	...	...	...	...	458 lb.
2. 3-years rest under elephant grass and pigeon peas	...	...	...	...	645 lb.
3. 3-years rest under elephant grass only	...	...	...	...	552 lb.
4. 4-years rest under elephant grass only	...	...	...	...	658 lb.
5. 5-years rest under elephant grass only	...	...	...	...	696 lb.

Yield differences were significant at the 5% level, a significant difference being 192 lb. per acre ; thus treatments 4 and 5 significantly outyielded the control. In view of the abnormality of the season, however these results must be treated with caution. The addition of a pulse appeared to improve the 3 year rest period. Further experimentation and longer experience of rest-cropping practices are required, but it would seem that three years of rest is the minimum. The whole series of plots has been sampled and soil studies are in progress.

The drought had a marked effect on the germination of Itch Bean, *Stizolobium* sp., and this perennial nuisance was very little in evidence. The seed appears to lie dormant and it will be interesting to see what happens if the rains next season are normal.

Mixed Cropping.—An experiment to compare pure crops of maize and of cotton with varying mixtures of the two (see pages 105-107 of

last year's report), was carried out in a field which had just emerged from its grass rest and was in a good state of fertility. The results follow:—

<i>Treatment.</i>	<i>Yield of Seed Cotton and Maize Cobs lb. per Acre.</i>	<i>% on equal area basis.</i>
100% Cotton	685	100
75% Cotton	601	88
25% Maize	2,723	152
80% Cotton	595	87
20% Maize	2,865	159
100% Maize	1,797	100

Differences in maize yields were highly significant, owing no doubt to the wider spacing, and although the cotton yields did not differ significantly, the trend was the same as in the 1947-48 season's experiments and the same general conclusions can be drawn. It is not proposed to repeat this experiment with true summer-crop cotton on the Station but it may well be worth doing elsewhere for educational purposes.

ROTATION CROPS.

Maize.—This crop was planted under conditions which would not have been unfavourable had one or two good soaking rains fallen in early January. Fairly good initial stands were obtained but the January drought gave all but the best fields a very bad time and growth was very patchy. A heavy storm with high wind in mid-March laid much of the crop but it managed to grow away in February. The final result was the worst crop ever experienced at the Station—a bare two bags of grain per acre.

The $2 \times 2 \times 2$ factorial experiment, repeated for the last time, was a failure, but since this has given only one result of interest, as reported last year, probably nothing of value was lost.

The land clearing experiment was repeated on the same plots to test residual effects but none were evident—all treatments gave about the same yield. The effects of "Maoza"* are therefore transient.

Groundnuts.—About ten acres of each of the varieties Gambia Bunch and Mwitunde were grown. The former, an early type, did better than the latter, but neither gave a good yield. Mwitunde yielded much less than, and Gambia Bunch about three times, the weight of seed planted. A new variety collection is being made.

Sorghum.—An area of $32\frac{1}{2}$ acres of sorghum was sown and 20 acres were carried forward as ratoon. Growth was very poor indeed and only 7,610 pounds of heads were harvested—an average yield of only 145 lb. of heads per acre. The land under this crop is reverting to

*The practice of clearing and burying debris during the rains.

grass rest. Further plantings in other fields are to be tried next season and selection is being started on local strains and new introductions from the Sudan and Tanganyika.

TANKS AND DAMS.

No dam contained more than a small surface puddle and there was no run-off into them from any of the lands. The large dam on Trust Land was completed and minor repair work was done to the experimental series. A native settlement, near the Trust Land dam, is beginning with new garden clearing.

SOIL STUDIES.

During the 1948-49 Season very little laboratory work could be undertaken, owing to lack of equipment and chemicals. A modified version of Martin's "Crumb Structure Analysis" was employed on samples from a run-down gravelly field which had been variously treated in the hope of improving fertility and structure. The results showed very little variation between treatments as regards crumb, but yields were significantly different as has already been reported. It seems that after the cover had been removed the "temporary colloids" provided by the crop debris were destroyed during the dry season and this appears to be the case in the top few inches where the heating and drying effects are greatest. This field had been cleared from rest in April/May, 1948, and sampled in November, 1948, before the break of the rains.

A few inspection pits have been dug but no laboratory examinations could be made. General observations such as soil structure and insect activity were noted. When equipment arrives a fresh series of profiles will be dug and examined.

In the coming season three field experiments will be undertaken :—

1. Varying quantities of a highly colloidal basic clay are to be incorporated in plots in a field similar to that examined this season.
2. An NPK experiment will be carried out in collaboration with the Department of Agriculture.
3. Nitrogen applications will be made to find the optimum time for top dressing and the largest quantity which can be applied economically. If more than one type of nitrogen fertilizer can be obtained a comparison will be made.

MISCELLANEOUS WORK.

The drought decidedly checked the work on weeds and grasses as their growth was very poor. No further attempts were made to seed grass leys.

Trial field sowings of $1\frac{1}{2}$ acres of bush Lima bean, *Phaseolus lunatus*, yielded almost exactly the amount of seed sown. Bush Lima bean and groundnuts are the only rain-grown pulses which have shown any real promise on dry land in this area, and further trials will be made.

COTTON BREEDING.

This season, breeding material and experiments occupied the entire cotton acreage and with the exception of a very small area under derivatives of CL.20-34 and a few control plots of commercial Crown Land Bulk (CLB), only derivatives of CL.20-20 were grown as it has been decided to concentrate exclusively on this strain. At the end of the season all CL.20-34 material was discarded as it is inferior to CL.20-20 and no better than CLB. A special bulk of the leading CL.20-20 strains was used for the Mixed Cropping and other experiments previously reported.

Family groups of 772 progeny rows and 80 small bulks were grown, and in fields 28 and 29 CLB was compared with 96 derivatives of CL.20-20 and CL.20-34 in two 7×7 lattice squares.

During the growing season an abnormally high incidence of black-arm disease occurred and the opportunity was taken to examine the breeding material for its degree of resistance. The results of this examination appear later in this report.

Node numbers of 100 random plants per strain were recorded in the lattice squares and strain means differed significantly. It is useful to know that a short range of maturation periods is present in the material should early or later maturing strains ever be required.

At maturity a bulk sample of 100 normal random bolls of seed cotton was obtained from each strain and an intensive laboratory analysis was made. The Bailey Halo method of lint measurement was replaced by the Harland system of measuring the mean maximum length of the stretched hairs. All measurements were carried out by Mr. Evelyn. The analysis, as will be seen from the following table, revealed that quite a fair amount of variation, irrespective of season, exists in the CL.20-20 material and so abundant possibilities are present for a fairly rapid improvement in most characters, particularly those affecting yield. Because of the bad season many of the derivatives which would normally have been discarded on the analytical results are being regrown as progeny rows for a further intensive analysis.

TABLE OF CHARACTER RANGES AND MEANS OF CL.20-20 STRAINS.

Characters.	No. of Strains.	Range.	Mean.	CL.20-20 Parent.	CLB (Comm.)
% Stand (Holes with plants, ...)	88	67.1-93.2	80.3	78.7	89.5
Mean node number (x 100 plants)	88	6.9-8.2	7.3	6.9	7.1
% Blackarm stem lesions	88	7.3-51.1	17.6	19.9	33.5
% Stained seed cotton (by weight)	88	27.2-48.5	38.5	43.6	47.7
Wt. of seed cotton per boll (gm.)	396	4.03- 7.45	5.2	5.1	4.0
Wt. lint per boll	396	1.34-2.63	1.7	1.8	1.3
No. of seeds per boll	396	27.1-43.80	33.0	34.7	27.1
Wt. of 100 seeds (gm.)	397	7.7-12.0	10.4	9.7	9.8
Lint index (gm.)	397	4.0-6.0	5.2	5.2	4.9
Ginning outturn (%)	397	30.1-37.0	33.4	34.9	33.0
Mean maximum lint length (mm.)	165	28.6-36.4	32.9	34.4	31.1
Actual yield (S/C per acre in lb.)	88	354-1,080	710	1,072	683
Adjusted yield (S/C per acre in lb.)	88	441-1,037	711	—	709

Data for the CL.20-20 Parent were obtained from only a single guard row at one side of the Lattice Squares Those for CLB were from replications. Individual plant node numbers ranged from 5 to 13 nodes before the first sympodium.

The Strain Trials.—Strain trials were conducted at Karonga in the Northern Province, at the Station and Sharpevale in the Central Province and at Lisungue, Kalembo and Mafumbe in the Southern Province. The results of the Out-station trials are not yet available as these were planted much later than those on the Station*.

At the Station, two 7 × 7 lattice squares with $\frac{1}{2}(p+1)$ replications, comparing 88 CL.20-20 and 8 CL.20-34 derivatives with Commercial Crown Land Bulk ex Chiromo, were sited in fields 28 and 29. These trials were the earliest sown and a fairly good initial stand was obtained. Field 29 was the poorer in fertility and suffered a much greater loss of stand during the January drought than field 28, and these conditions invalidated somewhat the yield comparisons in the second lattice square. Thus in the first lattice square, in field 28, twenty of the CL.20-20 strains outyielded CLB very significantly whereas in the second lattice square, in field 29, no CL.20-20 derivative significantly outyielded the CLB control. As varietal stand differences were highly significant in field 29 such a result must be viewed with caution. The fact that CLB gave almost identical yields in both trials suggests that this very mixed stock is highly adaptable to a wide range of fertility levels. However, many of the CL.20-20 derivatives also display this excellent character and selection with this object in view should soon lead to the building up of a composite bulk of the best strains which will be equally adaptable to varying conditions of soil and climate.

As CL.20-20 was itself extracted from CLB, it has been decided to make a further search in this commercial strain with the primary object of obtaining better strains for Lower River conditions, as the CL.20-20 series has been bred up mainly for Central Province conditions. To implement this, seed of this season's best CLB area in the Lower River will be grown at the Station next season and the "filtering" technique employed.

Seed of the CL.20-20 derivatives not needed by this Station or by the Group Farming Settlement Scheme has been bulked and will be multiplied next season at a nearby estate for preliminary issue to commercial growers. This will be followed later by further bulks of improved seed bred up at this Station.

* The trials at the Out-stations failed, mainly owing to drought, except at Sharpevale and Karonga where in each case CLB outyielded the CL.20-20 derivatives.

Samples of the highest yielding strains of the lattice squares, which also possessed good laboratory characters, have been sent to the Shirley Institute for hair and spinning tests along with control samples of CLB and the CL.20-20 parent.

PESTS AND DISEASES.

Insect Pests.—No flower taggings were done this season, partly because the bollworm situation seems to be stabilised at the Station and partly because irregular growth made recording of doubtful value.

Bollworm infestation was normal and calls for no comment but stainers were a source of trouble owing to the lateness and irregularity of the crop. At least four times as much cotton was stained as is usual (40% as against 10%), and heavy sorting was necessary to obtain spinning test material. This stainer attack is regarded as a direct outcome of the difficult season and should not be a cause for future worry.

Jassid, because of the high resistance of most of the CL.20-20 derivatives, was hardly to be observed, and no other pests made their presence felt.

Diseases : Blackarm (*X. malvacearum*.)

In March, a rainstorm of 0.9 inches accompanied by a high wind caused a good general infection of blackarm. Observations by the Government Pathologist and by Mr. Evelyn (who has had experience of this disease in the Sudan) leave no doubt about its identification. *Ascochyta gossypii*, with which it might be confused, has not yet been observed in Nyasaland. Leaf and stem lesion counts were recorded in both lattice squares and a statistical examination showed that although most of the CL.20-20 derivatives carry the high resistance factor B_2 , real differences in susceptibility exist, so that selection of homozygous resistant strains would be beneficial in the event of this disease ever becoming serious in Nyasaland. Covariance calculations with yield did not, however, suggest that blackarm was doing much damage. In the first trial a small negative correlation ($r = -0.12$), significant at the 1% level, was obtained but in the second trial a small positive correlation, insignificant when tested, was recorded.

SUMMARY OF MAIN CONCLUSIONS.

1. The season was one of severe drought which upset results and has given rise to local distress. The resisting capacity of cotton made it possible to obtain some results of value.
2. Foodcrops in general were a relative failure on the Station and at nearby areas; work on earlier types of sorghum is being undertaken to offset the possible effects of another drought.

3. CL.20-20 derivatives continue to show considerable promise and an intensive analysis of them has revealed that much improvement of the material is still possible.
4. There is nothing to add to comments made last year on pests and diseases except that blackarm occurs here, but not so far *Ascochyta gossypii*.

PROGRAMME FOR 1949-50.

With the increase of staff a considerable extension of work will be possible and new selection work with sorghum and other foodcrops will be undertaken ; otherwise the same general lines will be followed as in the past two years.

APPENDIX.

KEY TO STRAINS LISTED IN THIS REPORT.

CLB	Crown Land Bulk. The commercial cotton of Nyasaland, derived basically from U.4.
CL.20-20.	A high quality selection from Crown Land Bulk.
CL.20-34.	A selection, also from CLB, but much inferior to CL.20-20.

[Included by courtesy of the Southern Rhodesia Government.]

SOUTHERN RHODESIA.

COTTON RESEARCH STATION, GATOOMA. PROGRESS REPORT FOR THE SEASON 1948-49.

BY

A. H. MCKINSTRY AND R. W. JAMES.

Planting Period	...	...	...	8th—13th November, 1948, and again on the 21st and 22nd November, 1948.
Flowering	...	...	...	Mainly over the period middle of January to the middle of March, 1949.
Picking	...	...	...	May and June, 1949.
Legal Uprooting Date	...	...	...	30th September, 1949.

METEOROLOGY.

Exceptionally early rains amounting to 2·39 inches fell over the period 14th to 23rd October, 1948. Two showers of about half an inch each and three of about one-third of an inch contributed to this total. This rainfall enabled an early final pre-planting preparation to be given to several of the lands.

The first planting rains of the season fell on 7th November and the cotton was sown mainly during the second week of November. Planting operations were suspended during the third week of this month due to insufficient rain. The remaining small acreage of cotton was sown on the 21st and 22nd November.

The greater part of the maize acreage was planted concurrently with that of cotton : the remainder was sown in December.

Rainfall during December and in the first half of January, 1949, was, for the most part, meagre, resulting in drought-like conditions : in contrast, the frequent rains which fell towards the end of January and in early February made the lands very wet. Thereafter, owing to sparse rainfall, drought conditions again became established towards the end of February and for the remainder of the season.

Hail occurred at the end of January and caused marked damage in parts of some plots, especially the progeny rows and several of the crosses.

The total rainfall for the period 1st November, 1948, to 30th April, 1949, was 21·65 inches. This compares with 28·04 inches in 1947-48 and 16·51 inches in 1946-47.

AGRICULTURE.

Although the main work of the Station has been plant breeding, there have been, in addition, certain limited experiments in crop husbandry. Some of these (for instance spacing, time of planting, and the application of compost) have given results of practical importance, but the fact that the scope of these experiments has been limited emphasises the necessity for further investigation, using more modern statistical technique.

The time has arrived when it will have to be decided whether these important experiments should continue to be limited and restricted, or whether this station should undertake a more comprehensive programme of investigations which would benefit not only cotton growing, but also the whole system of mixed farming, in Rhodesia. A decision to undertake a more comprehensive programme would contribute to the realisation of the proposals of the Development Co-ordinating Commission, under the Chairmanship of Sir Frank Engledow, which published its Second Interim Report this year (Ref.: Para. 31). Consideration is now being given to such a programme. It can be foreseen, however, that a decision to carry out this work will require additional staff and facilities at Gatooma and closer contact with the different departments in the Division of Agriculture.

In the season under review the following results were obtained from experiments on agricultural practices.

A fertiliser placement trial was laid down in randomised blocks using the variety in commercial cultivation, 9L34. The fertiliser was applied when the plants were just starting to flower. Placement was by hand in a trench 5 inches deep, and 12 inches to one side of each row. Farm-made compost, superphosphate and lime were applied, each at two levels. Trenches were made on the control plots and filled in when they were reached by the natives applying the fertiliser.

Although the experiment gave no significant results when analysed by either the ordinary analysis of variance or by the analysis of covariance of yield on stand, it is possible that compost at 5 tons per acre and superphosphate at 200 lb. per acre will increase the yield of seed cotton per acre when applied, at the commencement of flowering, by the placement method. This experiment will be repeated this coming season, but the fertiliser will be applied at planting.

A trial with maize to test the residual effects of fertilisers applied to the previous season's cotton crop, and another on the post-harvest cultivation of old cotton lands to destroy Sudan bollworm pupæ prior to planting maize, gave no significant results. This was probably due to extreme soil heterogeneity which could not be statistically compensated for owing to the designs used.

Grasses.—Three grasses are being multiplied for use on the Station. One is Napier Fodder, from the Gold Coast, which should be of great benefit to the cattle when made into silage. The other two, *Panicum Makarikari* and *P. coloratum*, which both came from the Matopos Experiment Station, are to be used for experimental leys and hay-making.

All other strains and varieties of grasses have been handed over to the Soil Conservation Officer for the Umsweswe Area. The Cotton Research and Industry Board has also placed about 5 acres of land at his disposal to enable a grass nursery to be established for the benefit of farmers in the area.

Land Clearing.—Approximately 40 acres of land have been cleared this season from 200 acres of virgin bush bought in 1946. This land is remarkably free from rocky outcrops and will be a valuable addition to the area available for experimental purposes.

COTTON PLANT DEVELOPMENT AND CROP YIELD.

As a result of an erratic rainfall distribution during planting, the germination and brairding of the cotton crop on the Station took place unevenly during the third and fourth weeks of November. A small portion of the crop was thinned in the first week of December, but the thinning of the larger part was delayed until the fourth week of that month for want of rain.

The crop started to flower during the first week of January, and the main flowering occurred from the middle of January to the middle of March.

Sudan bollworm again caused most of the shedding of young squares, flowers and bolls during the very early flowering period, but subsequently, during the main flowering period, this pest did not take as heavy a toll of the crop as it frequently does. In fact, in 1949, loss of crop due to attacks by the three bollworms, Sudan, American, and Spiny, was of secondary importance to the loss through boll-shedding due to lack of rain. Thus for the first time in five seasons losses due to insect pests have been exceeded by losses due to environmental conditions.

The crop matured in March and April and was reaped in May and June. This is exceptionally early. It is probable that the main factors affecting this early maturity were comparative freedom from damage by bollworms, stainers, and jassid and also inadequate soil moisture.

Despite seemingly deficient moisture supplies, seed cotton yields of the leading varieties on the Station have been between 500 and 600 lb. seed cotton per acre and the length and quality of the lint are definitely good for 9L34.

Approximately 90 per cent. of the 1949 crop of seed cotton was classified as practically unstained. This compares with a similar figure obtained in 1947, a year in which conditions were even more droughty than those described for 1949. The 1948 crop, which was grown in a "wet" season, gave poorer yields than, and lint and seed inferior in quality to, the 1947 and 1949 crops.

Throughout the country it has been a year in which good to very good yields of seed cotton have been obtained by both European and African farmers. Mediocre crops were few, and failures exceptional.

In the Mondoro Reserve 1,133 African farmers cultivated between them a total of 1,080 acres of cotton, in a system of mixed farming, and they obtained a mean yield of approximately 780 lb. seed cotton per acre. Other Reserves, notably Bikita and Merewa, have produced smaller but high yielding crops of seed cotton.

It seems likely that the numbers of African growers will increase considerably in the near future as a result of this outstanding success in the Mondoro Reserve and the policy of payment of "cash over the counter" for the cotton crop. A planned programme of expansion is being developed.

COTTON BREEDING.

The main work of the Station since its inception 25 years ago has been the breeding of varieties of cotton suitable for commercial cultivation under the agricultural conditions of Southern Rhodesia. In addition to this work there have been subordinate investigations into the control of insect pests and methods of crop husbandry.

Plant breeding work to date has been confined mainly to two sources of material, the most important being derivatives by straight line breeding from Parnell's U.4, selected at Barberton in 1925. The secondary source came from a cross between U.4 and Cambodia made in 1936 at this station. Further material has been imported from time to time from experimental stations in other countries but nothing of value has been obtained. With the outstanding exception of U.4 none of the many imported varieties has been found sufficiently useful for Rhodesian conditions.

At present 9L34, the variety in commercial cultivation, represents the furthest advance made by straight selection within U.4 derivatives, and 12204 and its sister strain 12405 are among the best of the varieties selected from the (U.4 $\times$ Cambodia) $\times$ U.4 crosses, commonly referred to as the 7Cs. Although 9L34 has a better lint length than 12204, this variety is definitely superior to 9L34 in yield, and in ginning percentage, as will be seen from the figures in Table I.

TABLE I.

<i>Ancestry.</i>	<i>Strain.</i>	<i>Yield lb. seed cotton per acre.</i>	<i>Yield lb. lint.</i>	<i>Gin %.</i>	<i>Seed Wt. in Grammes.</i>
Cambodia × U.4/64/7/10 ²	12204	527	182	34.5	8.8
Cambodia × U.4/64/7/10 ²	12405	425	148	34.8	9.3
9L34	4553	397	130	32.6	9.0
12405	4644	394	139	35.4	8.6
U.4/64/V/No. 3	9L34	373	120	32.3	9.3
12405	4583	352	122	34.5	9.5
General Mean		411	140	34.0	9.1
S.E. Single plot		±49	±17	±0.5	±0.4
P 0.05		44	15	0.5	0.4
P 0.001		78	26	0.8	0.7

Both these varieties have harsh lint which is characteristic of U.4 and also possess a sufficient degree of jassid resistance for all normal purposes. 9L34 because of its better lint length is preferred by the local spinning industry for the existing mill : but there will probably be a demand for 12204 when the second mill, now in process of construction, is completed. For this reason stocks of 12204 and 12405 seed, from a multiplication made in the past season, are being held in reserve.

Certain characters which are now considered to be desirable improvements are not present in the genetical constitution of the U.4 and U.4-Cambodia hybrid material available in the breeding lines to-day. These characters are :—

- (1) A degree of hairiness conferring jassid immunity instead of a standard of hairiness which results in more or less satisfactory resistance under normal conditions.
- (2) Lint fineness and silkiness in place of the present lint harshness.
- (3) A " spindle " or " pencil " type of plant of a cluster habit suitable for harvesting by mechanical cotton picking machinery.
- (4) If obtainable, resistance to one or more of the bollworms, Sudan, American, and Spiny.

In an attempt to obtain these characters in combination with existing useful ones in the U.4 and 7C varieties, a programme of hybridisation has been started. It is well known that such a programme will require much more time and labour for a thorough examination and analysis of F₂ and subsequent generations than is demanded by straight selection work. This is, however, work which cannot be done for Rhodesian conditions by Stations in other countries, as it has been amply demonstrated in the past that, in almost all cases, varieties bred at other Stations, even as close as Barberton, fail to yield worthwhile results when imported and tested at Gatooma.

The following are notes on the main plant breeding material at present under investigation.

U.4 Varieties.—9L34 is at present in commercial cultivation. Over the past five seasons the progeny of selections taken from 9L34 and closely related strains have shown no definite improvement on their parents in yield in combination with desirable lint characters. In general, it appears that when yield has been higher lint length has been poorer. Also, when seed weights have been higher they have been unaccompanied by a corresponding increase in the lint indices, with a result that ginning percentages have been relatively poor. However, although it seems unlikely that definite improvements will be achieved from within 9L34 and allied strains, this variety should continue to be useful commercially until better material is available.

7C Varieties.—Present-day derivatives of the (Gatooma U.4 × Cambodia) × U.4 cross are in general heavier yielders with appreciably better ginning percentages than 9L34. The lint of the 7Cs is, however, definitely short. A number of 7C derivatives have a type of plant habit suitable for mechanical picking. One of these, 12405, sown by machine in the Gatooma area at a rate of 15 lb. acid delinted seed per acre and left unthinned, yielded 1,200 lb. seed cotton per acre. From this result it would seem that there may not be the need for great attention in thinning mechanical picker plant types as is necessary with the more “bushy” types, provided that the rate of seeding per acre is adjusted carefully.

Kidney outcross.—Seed from two selections 4/129/1 and 4/129/5, bearing this name was sent by Prentice in 1945. From an examination of the segregating F_4 and F_5 progeny it seems probable that the unknown parent is *G. hirsutum*. Certain selected progeny, of an annual sympodial type, have long dense lamina hairs which confer “super resistance” to jassid. The lint is fine, silky, very strong, and of good length. These plants were selected at the beginning of the season and used as parents in a backcross (?) to *G. hirsutum* using U.4 material.

Quality linted Americans × U.4 derivatives.—Unavoidably small F_2 s were grown of crosses made in the Sudan between the Gatooma U.4s (4570 and 4553) and the 7C (12490) with, in each case, Meade and Tidewater. Hail caused appreciable damage to these plots. Nevertheless, a number of selections representing the F_3 s of these crosses have been taken.

MU8A × Tidewater.—The F_1 seed of this cross was given to the Station by Parnell in 1946. It was planted in a small plot in 1946–47 and ratooned in the following years. A small F_2 was planted in 1947–48 and a few selections were taken. The F_3 s planted this season in progeny rows were disappointing and no reselections were made. Another F_2 was planted in a small bulk this season and a few selections have been taken.

MU8 × BP52².—One F_3 (A5851 SB) and three F_3 (A616, A618, A619) derivatives of this cross were obtained from Barberton and grown at Gatooma for the first time in 1949 in small observation plots.

Results, in terms of yield, combined with better quality lint, have been so promising from these new introductions that a further number of selections have been obtained from Barberton. The original cross and backcross will be repeated at Gatooma for selection purposes in earlier generations.

U.4 × Sea Island.—The Barberton derivatives of this cross—namely, A6553, A7832, A7862 and A6445—were grown for the first time. Their yields were poor or very poor, in striking contrast to the MU8 × BP52² lots which were in adjacent plots. They have been discarded.

COTTON PESTS.

As a result of many seasons' recording work, the basic factors relating to the incidence and habits of different insect pests of cotton are well known for the present main cotton growing areas of Southern Rhodesia. This series of seasonal records will, therefore, be curtailed.

It is considered that, with the exception of increasing jassid resistance to the point of immunity and, if practicable, breeding for bollworm resistance, further improvement in yield, through plant breeding methods which result in partially evading insect pests, is unlikely.

There remains the work of investigating various direct measures for the control of the pests. In this field, it is only possible, with present staff and facilities, to plan for a limited number of experiments with insecticides. The results of three such experiments are reported in later paragraphs.

In the season under review insect pest damage was the lightest on record for many years and the yield of seed cotton per acre throughout the country was above average. Boll sheds due to bollworm damage were outnumbered by the sheds due to other causes. The opposite is usually the case. Stainer damage was very light. This is indicated by the fact that over 90 per cent. of the crop was classified as unstained seed cotton.

A large number of farms in different parts of the country were visited by members of the staff during the season. From observations made on the spot and from reports received from other farms it can now be confirmed that insect pests, the Sudan bollworm in particular, limit the amount of seed cotton produced by Gatooma-bred strains to a greater extent than a sparse and erratic rainfall. This conclusion indicates the necessity for research into the nature, and the possibilities of transference, of bollworm resistance from wild cottons to the commercial strains to be issued in the future.

Advanced research work is already in progress at other centres on measures to control insect pests, the results of which, with modifications if necessary, should be applicable in Southern Rhodesia.

The following experiments are reported :—

In the two previous seasons' experiments with DDT preparations, the cotton crop received an application of about 7 tons of compost per acre. Furthermore, in the 1946-47 experiment a DDT wettable powder, then the only one procurable, was applied late in the flowering life of the plants, while in the 1947-48 trial the plants had been in flower for six weeks before the first application of different kinds of DDT liquid preparations was made. In these trials yield results were statistically significant in favour of the DDT wettable powder in 1946-47 and of a DDT emulsion liquid in 1947-48, as compared with the control or no treatment plots.

During 1948-49 there were two experiments with the same series of DDT wettable powder and emulsion treatments. The preparations used were supplied free of charge through the courtesy of Messrs. Klipfontein Organic Products S.A. The insecticides were applied on the same dates in both experiments. There was, however, a major difference between these two trials in that in the one laid down in randomised blocks the cotton had received 7 tons compost per acre, while in the other, laid down in four latin squares, no compost had been applied.

Both of these trials also differed from those of the two previous seasons in that the time of the first application of the insecticides was during the first week of flowering, i.e. in the first week of January, 1949. A second application was made on the 14th February and a third on the 26th February, these times being to some extent controlled by climatic conditions.

The following deductions are made from the results of these trials, which are shown in Table II.

TABLE II.

Treatment.	lb. DDT* / gals. water per acre.			Composted. (7 tons p.a.) yield seed cotton.	Uncomposted	
					yield seed cotton.	eye judgmen of plants after treatment.
	1	2	3	(lb. p.a.)	(lb. p.a.)	1 = bad 10 = good
1. Control	—	—	—	350	318	7.0
2. E27 Emulsion Liquid	25	50	50	420	294	5.3
3. " " "	25	50	50	364	293	5.3
4. 50% Wettable Powder	25	50	50	373	209	4.9
5. " " "	25	50	50	365	189	4.7
Gen. Mean				375	250	5.4
Standard error single Plot				± 33	± 14	
Significant Difference : P 0.05				40	39	0.7

*The Wettable powder contained 50% DDT and the Emulsion Liquid 27.5% DDT. The figures give the actual weight of the DDT applied per acre per application, and not the weight of the Commercial product per acre, per application.

Yields in the trial receiving compost were on an average 125 lb. seed cotton per acre greater than in the uncomposted experiment. Although these results are not comparable statistically, it is confirmatory evidence that the yield of cotton is increased by an application of compost.

In the composted trial the yield of the emulsion treatment (No. 2) was significantly greater than all the other treatments, with P less than 0.05. There was no significant difference between the other treatments. The poorest yield was given by the control.

In the uncomposted trial there was no significant difference between the control and the emulsion treatment (No. 2), but these two treatments were significantly better than all the others with P less than 0.05.

As there is no consistent and definite yield advantage in favour of applying DDT emulsion under different conditions of soil fertility, no recommendations can be made to cotton growers at present.

In a third experiment involving the use of insecticides, two applications of a dust containing 3 per cent. benzene hexachloride, 5 per cent. DDT and 40 per cent. sulphur were made, the first when the cotton plants were in their second week of flowering and the second about five weeks later. The mean yield of the undusted plots was 347 lb. seed cotton per acre as compared with 383 lb. for the 3-5-40 treatment. The gain of approximately 40 lb. of seed cotton per acre (which is valued at about 25s. to 30s. at the 1949 Southern Rhodesian price levels for seed cotton) was not statistically significant.

SUMMARY AND CONCLUSIONS.

Exceptionally early rains amounting to 2.39 inches fell during the third week of October. True planting rains commenced in the second week of November, 1948. Subsequently, during the greater part of the season, rainfall was meagre, except for a period of about two weeks covering late January and early February, when frequent rains resulted in superfluous soil moisture.

Insect pests' attack and damage throughout the country as a whole were the lightest on record for many seasons. In fact the Station's records show that boll shedding due to bollworm damage was appreciably less than the shedding due to other causes, and, again, the percentage of stained seed cotton was small, as approximately 90 per cent. of the crop was classified as practically unstained.

Owing to the remarkably light insect pest attack and in spite of the drought-like character of the season, above average yields of seed cotton per acre were obtained by both European and African growers. As an example, which is taken from exact records, 1,133 African farmers, who cultivated between them a total of 1,080 acres of cotton in the

Mondoro Reserve in a system of mixed farming, obtained a mean yield of approximately 780 lb. seed cotton per acre. This crop brought in a total cash return to the growers of approximately £30,124.

Indeed, the quantity of cotton grown by Africans promises to expand rapidly, and plans are being evolved which should enable this expansion to progress soundly, to the benefit of both agriculture and the African's economic well-being. The number of European growers who realise the varied benefits to be derived from cotton growing in a system of mixed farming also shows signs of a steady increase.

In the plant breeding work of the Station it is now apparent that improvements in yield and lint quality will not be obtained from the existing U.4-derived varieties, inclusive of varieties selected from U.4 $\times$ Cambodia crosses made in 1937. For this reason a programme of hybridisation has been started in an attempt to obtain the desired combination of characters indicated in this report. The examination and analysis of hybrid material will occupy more time than that given formerly to straight line breeding with U.4 material. In fact, the present staff can do little more than concentrate on the hybridisation work. It is apparent that until more staff and facilities are available only a limited number of experiments covering the important fields of agricultural practices and entomology will be possible. The importance of these two fields of investigation in relation to the plant breeding work is discussed in the report.

PROGRAMME FOR 1949-50.

(1) Expansion of the plant breeding programme, to include hybridisation in an attempt to :—

- (a) Increase jassid resistance to the point of immunity.
- (b) Improve lint quality, but not necessarily to increase lint length above the present standard of $1\frac{1}{8}$ in. cotton.
- (c) Obtain a plant type more suitable for mechanical cotton pickers than the present shapely sympodial type.
- (d) Investigate the possibilities of obtaining resistance to one or more of the bollworms, and at the same time retain the standards of earliness and fruitfulness, present in the U.4 material.

(2) Limited experiments on agricultural practices and the control of insect pests as time permits,

[Included by courtesy of the Nigerian Government.]

NIGERIA.

PROGRESS REPORT ON COTTON IN THE NORTHERN PROVINCES FOR THE SEASON 1948-49.

Normal Planting dates	...	...	Late June to end of July.
Normal Picking dates	...	...	December to February.

METEOROLOGY.

The total rainfall at Samaru for the season was 35·3 inches, this being about 8 inches below the average for the previous ten years. This lower total was accompanied by the unusually early cessation of the rains, the last fall being on 30th September, instead of showers and damp cloudy weather continuing into October. This probably had an adverse effect on the total yield of cotton, and perhaps also on the quality, particularly of the later sown crops. Premature termination of the rainy season was general over the main cotton growing areas.

INTRODUCTORY NOTE.

The inherent agricultural circumstances have remained substantially unchanged since the publication of the 1943-44 report in which they were described at length. The position of cotton as an export crop has, however, become more important with the increased demand for cotton from sources within the sterling area. It is possible also that a somewhat smaller proportion of the cotton grown is now consumed locally as supplies of both manufactured cotton cloth and yarn from abroad, interrupted during the war years, are now again becoming available.

The total ginned for export from the 1948-49 crop reached 47,904 bales, a very substantial increase over the previous season. With weather conditions not particularly favourable, yields per acre were probably not in general much higher than in 1947-48 and the increase is to be attributed mainly to the planting of a larger acreage. The overall increase in seed issued amounted to 800 tons. The heavier demand for seed followed the announcement, in advance of the planting season, of a flat rate for the purchase price of seed cotton irrespective of transport costs from outlying markets. This meant a substantial increase in the price to be received by the cultivator in some areas.

The main progress to be recorded in the breeding work is the continued satisfactory results shown by the selected strain "Samaru 26C," in comparative trials against the present commercial stock of Allen variety. This was accompanied by the successful carrying one stage further of the large scale multiplication of seed of this strain. If progress continues according to programme an area approaching 40,000 acres will be under this selected strain in season 1950-51.

A considerable number of reselections from 26C were carried forward and lint samples obtained for spinning tests.

Useful indications as to the value of a range of imported strains were obtained. Of these, MU8B, already found to be early, vigorous and heavy cropping under Samaru conditions, again did well in yield.

BREEDING WORK.

Single Plant Selections.—Selections were made in two sets of material, the first representing 26C (of which 51 progeny rows were grown) and the second consisting of a collection of "native" cottons originating from Maiduguri on the north-eastern fringe of the main cotton growing region.

In all 100 selections were made from 26C stock and 120 from the Maiduguri material, this latter being given increased attention on account of favourable reports on the maturity of lint samples sent to the Shirley Institute from 1946-47 plots.

Lint samples from 20 of the 26C progenies and from a number of the "native" strains were taken for small scale spinning tests. In addition, selfed seed of each of the single plant selections of 26C progenies was sent for testing for blackarm resistance by the Corporation's staff working at Shambat in the Anglo-Egyptian Sudan.

Observation Plots of Introduced Strains.—In addition to the inclusion of a few of the most promising types in variety tests (see later) a number of other introductions from the Sudan were grown for a second season and kept under observation.

Replicated Variety Tests.—Two tests were laid out to compare with 26C four of the more promising of the recent introductions referred to in last season's report. As earliness of cropping was one of the characteristics of note in these introduced strains, it was arranged to sow one of the tests a month later than the date which is considered to be the optimum for cotton sowing at Samaru in a normal season. The results obtained are set out in the table below.

YIELDS OF INTRODUCED STRAINS AT TWO DATES OF SOWING.

(Lint in lb. per acre).

Strain.	Sown 1st July.	Sown 31st July.	% Drop.
MU8B	256	49	81
26C	210	41	80
Parbhani III	146	35	76
Esfahan	129	30	77
Koghuzi	92	23	75
S.E.	±11.6	±3.4	

None of the introduced strains seemed any more tolerant of the delay in sowing than the local 26C and, whether sown early or late, none but MU8B yielded as well as 26C.

It should be noted that the very big drop in yield with the second sowing cannot be attributed solely to date of sowing. The field used was on poorer soil than that utilized for the first sowing and was not manured. The comparison was between "good conditions" (including optimum sowing date) and "bad conditions" (including delayed

sowing). The unusually early cessation of rains may be considered to have accentuated the difference.

The high yield given by MU8B (22 per cent. increase over 26C) is worthy of note. This strain itself is quite unsuitable for growth in Nigeria for the production of export lint, to sell in the Allen market, being of definitely shorter staple. There is, moreover, little hope of obtaining any marked improvement in length by selection within it. A number of hybrid types having MU8 as one parent and possessing better lint length have, however, been imported for trial. Some of these may reproduce the good yielding power shown by MU8 here.

In the earlier sown of these two tests three strains related to 26C were also included together with commercial Allen seed from Funtua ginnery. The results for these strains, taking 26C as the standard of comparison, are given below.

YIELDS OF 26C AND RELATIVES AT SAMARU.

								Lint Yield lb. per acre.	% of 26C
26F	...	...	...	...	...	...	...	235	112
26E	...	...	...	...	...	...	...	222	106
26C	...	...	...	...	...	...	...	210	100
26I	...	...	...	...	...	...	...	203	97
Allen	...	...	...	...	...	...	...	204	97
S.E.	...	...	...	...	...	...	...	±11.6	± 5.5

A third variety test, sited at Daudawa, included a further comparison of 26C with some related types and with commercial Allen. The results are given below. The three lots of 26C (viz. "selfed," "Stage 0" and Stage 1") represented three stages in the multiplication scheme in operation for this strain at Daudawa. As was to be expected, no differences in seed cotton yield, ginning percentage or lint yield occurred between them greater than could be attributed to experimental error.

YIELDS OF DAUDAWA VARIETY TEST.

				Seed Cotton. lb. per acre.	Lint. lb. per acre.	Ginning. %
26C :						
From selfed seed	...	...	...	426	150 (102)*	35.3
" Stage 0 "	...	...	...	380	137 (94)	36.2
" " 1 "	...	...	...	434	153 (104)	35.3
Mean for 26C lots	...	...	...	413	147 (100)	35.6
COMMERCIAL ALLEN :						
Seed from Funtua	...	...	...	305	99 (68)	32.6
RESELECTION FROM 26C :						
26G	...	...	...	403	143 (97)	35.6
26H	...	...	...	374	133 (91)	35.5
STRAINS RELATED TO 26C :						
26E	...	...	...	361	130 (88)	36.1
26F	...	...	...	360	126 (86)	35.1
26I	...	...	...	395	141 (96)	35.6
S.E.	...	...	...	±21.6	± 7.6 (5.2)	

*(The figures in brackets show lint yields relative to 26C = 100).

The yields of 26E and 26F do not correspond at all closely with those recorded at Samaru but in neither test did they differ significantly from 26C. The indication that 26I is about equal in yield to 26C is pleasing as this strain shows promise of an improvement in lint quality.

The relative yields of 26C and Allen in the two tests are inconsistent. The very big difference shown at Daudawa must be partly discounted as the Allen plots had to be almost entirely resown nine days after the original sowing. At the same time, differences of this order have been recorded more than once in previous tests. The lack of any big difference at Samaru can only be put down to unknown causes. Figures comparing these two strains in mean performance over many seasons are given in a later section.

Seed Multiplication.—The usual plot of strain 26C, to produce self-bred seed for sowing "Stage O" of the Daudawa multiplication scheme, was sown and fifty pounds of selfed seed were produced for that purpose, as well as a further quantity for use in sowing next season's experiments.

Stocks of various other strains were renewed by the production of self-bred seed from numerous small plots.

Performance of Strain 26C.—Reference has been made in the introductory note to the multiplication of seed of the selected strain known as Samaru 26C. This strain was produced by single plant selection in the commercial Allen stock, followed by repeated re-selection in progeny rows. Details of this work have been published (Freeman 1946), but it is now possible to add to the performance data given. In all, seed cotton yields from nine replicated experiments at Samaru and Daudawa are now available together with ginning percentages and lint yields from eight of these.

Taking all the tests together, the average yield and the percentage increase shown by 26C over Allen (commercial stock from Funtua ginnery) was as follows :—

	26C	Allen.	% Increase.
Seed-Cotton (lb. per acre)	498	465	7
Lint (" ")	182	147	24
Ginning Percentage	35.4	30.5	16

It is evident that the decision to proceed with the large scale multiplication of this strain is amply justified on grounds of yield. The increase in ginning percentage shown in variety tests has been reproduced in the ginning of the produce of the multiplication areas at Funtua ginnery.

Regarding lint quality, the data available so far are less adequate ; the reports on the most recent samples to be submitted to the Shirley Institute are not yet available. On the average of the results received, it appears that 26C may be taken as almost equal to commercial Allen in yarn strength, while showing a very definite improvement in maturity and, in consequence, giving yarns of consistently better appearance. Allen itself is of very satisfactory lint quality in all respects except its tendency to excessive neppiness. The improved maturity shown by 26C is therefore an important feature and its reduced tendency to nep should be welcomed by the spinners.

It will naturally be some years yet before reliable comparisons can be made between commercial quantities of the two types. The

various ginnery areas and their subdivisions differ quite considerably in the average quality of the crop. The choice of sites for the various stages of the seed multiplication scheme is made almost entirely on grounds of ease of control of seed—issue and marketing. It does not take into account the reputation of the areas for quality. In consequence lint in commercial quantities from these multiplication areas of 26C may well be found below the quality of the best samples of Northern Nigerian Allen.

REPORT ON LINT SAMPLES FROM THE 1947-48 CROP.

Some of the information on the relative lint quality of the strains under trial, obtained from the Shirley Institute report on 1947-48 samples, has been embodied in the foregoing sections but some further data of interest, although referring to the previous season, are worthy of inclusion here.

Two samples of imported strains were sent for test expressly in connection with the problem of maturity. These were UA4—1 and UA4—3. Grown in Trinidad, the former was found to give a much better lint maturity ratio than the latter. The results from the Samaru-grown samples were:—

UA4—1	...	0.865
UA4—3	...	0.715

This difference, although not extreme, is substantial, and supports the view that genetic differences in this character can manifest themselves under Nigerian conditions.

Amongst all the imported strains the extreme range shown was from 1.095 to 0.690 but, as the samples were from unreplicated plots, an unknown proportion of this difference may be due to soil variation.

Samples sent from a planting date experiment, sown with strain 26C, showed a tendency for later sowings to give shorter, less mature lint and yarn of rather lower strength and poorer appearance. The differences, however, were considerably smaller than might have been expected. Only in the case of the last sowing (September 5th, which is an extremely late date) was the drop in spinning quality substantial.

Successive pickings over the period December to February (in the case of the earlier sowings only) showed a similar trend, the drop in effective length being the most conspicuous feature, though still not very great (from 39 to 36 in 1/32nds of an inch).

PHYSIOLOGICAL EXPERIMENTS.

Effect of Growing Conditions on Lint Maturity.—In view of the importance of improving the maturity of the Northern Nigerian cotton crop it is desirable to learn more of the factors governing lint maturity, and particularly to decide to what extent the immaturity is a result of external conditions.

With this in view, an experiment was carried out in which small plots of 26C cotton were grown under a range of treatments designed to influence growth, particularly during the latter part of the season. These included one plot receiving 10 tons of farm-yard manure (before planting) and waterings equivalent to half an inch of rain every third day from the termination of the rains onward until the extreme end of the season.

Samples of lint from these plots have been submitted to the Shirley Institute and a report on them is awaited.

Permanent Rotation Experiment.—Following up a suggestion made by Dr. J. B. Hutchinson, a permanent experiment has been started, as part of the general programme of work of the station, in which cotton appears in rotation with guinea corn (*Sorghum* sp.) and ground-nuts. A series of standardized records on the growth of the crops, to be continued over a series of years, have been initiated. Results, in the form of correlations between growth and climate, will not of course begin to emerge for several years. The cotton crops in this experiment are being sampled for annual variations in lint quality.

REFERENCE.

Freeman W. E., 1946. "Samaru 26C—A New Strain of Cotton Bred In Northern Nigeria."—*Tropical Agriculture* XXIII, 6. 109-113.

PROGRAMME FOR 1949-50.

With the object of assisting the Nigerian Government in a drive for a large increase in the production of cotton for export, the Empire Cotton Growing Corporation arranged to station one of their officers at Samaru for full time work on cotton breeding from the commencement of the 1949-50 season.

In consequence it is hoped to carry through a considerably larger programme than was possible for a single senior Government officer charged with responsibility for all botanical work on every crop of Northern Nigeria.

The primary objective is a strain giving higher yields through greater inherent fruitfulness, combined with robust growth and resistance to pests and diseases. Attention will also be paid to reducing the tendency of Northern Nigerian cotton to excessive neppiness while retaining the general character of Allen lint.

With these objectives in view, much attention will be directed to the reselections from 26C and related types already in existence and showing much promise. In addition, numbers of new single plant selections will be made from bulk 26C and Allen and from all other material existing at Samaru considered to show promise.

To assist in sorting miscellaneous local strains and a number of importations from the Sudan and East and South Africa, a replicated test containing 72 strains in sevenfold replication has been designed. Amongst these strains are eight hybrids having MU8 as one parent.

Tests will be carried out at Samaru and Daudawa to compare amongst themselves various stocks of 26C and related types, with the addition of commercial Allen as "control." Taken together these tests will yield a comparison of 26C with Allen in 31-fold replication.

Local staff will be trained in laboratory methods and a range of lint samples will be taken for submission to Shirley Institute.

Nucleus seed of 26C will be produced for the multiplication scheme at Daudawa and co-operation maintained with the officers responsible for that scheme and for other aspects of cotton production and grading.

FERTILIZER TRIALS WITH COTTON

I. SAMARU.

Interaction of Nitrogen and Phosphate.

This trial was a continuation of one laid down in 1947, and fertilizers were applied again at the same rates to the same plots. In 1947 various methods of applying the fertilizers were tried: these treatments were omitted in 1948. Superphosphate mixed with soil was applied in a thin channel made at the summit of the ridge immediately prior to planting. Sulphate of ammonia was mixed with soil and ringed round the seedlings on the 22nd day after planting: stands had been reduced to 2 seedlings on the 20th day. Both fertilizers were earthed over after application.

There were 6 replicates of the 9 combinations of:—

n0	= Sulphate of ammonia	0 lb. per acre.
n1	= " " "	50 lb. " "
n2	= " " "	100 lb. " "
p0	= Superphosphate	0 lb. " "
p1	= " "	50 lb. " "
p2	= " "	100 lb. " "

Selection 26C was planted on July 7th. Germination was good and few supplies were needed. An increase in height due to superphosphate was apparent on July 21st, and a darker green due to nitrogen was noticed on August 17th, 19 days after application. Height measurements made on September 8th showed a highly significant increase due to superphosphate and a lesser effect due to sulphate of ammonia almost wholly derived from its positive interaction with superphosphate. Extreme mean heights in cm. were:— $n_0 p_0 = 24.7$; $n_2 p_2 = 55.5$: the treatment order was roughly the same as that for stalk weights given below.

Flowering began in early September. A flower count made on September 8th showed a highly significant increase in flowers due to superphosphate : there was a smaller significant effect due to nitrogen again derived from interaction with superphosphate. In a second count made on October 16th the phosphate effect remained highly significant whilst the response to nitrogen had lost significance.

The crop suffered attack from leaf-roller, red bollworm and monkeys. Counts of healthy and damaged bolls made on October 16th and November 24th showed that the percentage of damaged bolls rose steeply with an increase in the number of bolls per treatment. Thus the percentage damage was only 17.4 in treatment $n_0 p_0$ (3.55 total bolls per stand), but reached 41.2 in treatment $n_2 p_2$ in which the mean total number of bolls per stand was 8.87. Samples of diseased bolls and of all pickings from one block were handed to the Cotton Entomologist, Mr. Geering, for examination.

The cotton was picked between October 25th and January 27th. Yields in lb. seed cotton per acre are given below. Ginning percentage, as determined on two random samples from the mixed seed cotton, was 34.8.

Yields of Seed Cotton (lb. per acre).

	p_0	p_1	p_2	Mean.
n_0	152	282	256	230
n_1	161	281	354	265
n_2	187	278	337	267
Mean	166	280	316	254

Sig. Diff. Single Treatment 1% = 115 : 5% = 86.

Means 1% = 67 : 5% = 50.

Weights of stalk were determined on March 30th on the uprooted dried plants.

Yields of Stalk (lb. per acre).

	p_0	p_1	p_2	Mean.
n_0	452	1096	1313	954
n_1	682	1451	1835	1323
n_2	514	1723	2225	1487
Mean	549	1423	1791	1255

Sig. Diff. Single Treatment : 1% = 448 : 5% = 334.

Means 1% = 258 : 5% = 193.

Seed Cotton.—There was no significant effect due to sulphate of ammonia or to its interaction with superphosphate. The response to both rates of superphosphate was significant at 1%. 50 lb. superphosphate raised the yield by 114 lb. seed cotton per acre, an increase of 69% : the further increase of 36 lb. given by 100 lb. superphosphate was not significant.

It should be noted that the increment due to 50 lb. superphosphate was highly remunerative. The Zaria price for superphosphate is £20 per ton, i.e. the cost of 50 lb. is 9/-. The value of 114 lb. seed cotton at 4d. per lb. is 38/-.

Stalk.—The main effects of both sulphate of ammonia and superphosphate and their interaction were significant at 1%.

The increase in stalk yield due to 50 lb. sulphate of ammonia was 369 lb. = 38.7% of no nitrogen. The increase of 535 lb. due to 100 lb. was not significantly greater.

50 lb. superphosphate gives an increment of 874 lb. = 159% of no phosphate. The increment of 1242 lb. due to 100 lb. superphosphate was significantly greater at 1%.

The mean response to sulphate of ammonia was 146 lb. in the absence of phosphate : 491 lb. in the presence of 50 lb. and 718 lb. in the presence of 100 lb. superphosphate.

In view of the greater pest damage in the better grown plots, it is probable that the nitrogen/phosphate interaction on seed cotton yields was a real effect, though it did not reach the level of significance.

2. DAUDAWA.

Placement Trials on Settlers' Farms.

It was intended to carry out comparative trials of superphosphate pellets and superphosphate in powder form on a number of settlers' farms. Diversion of the superphosphate pellets to other experiments led to the use of pellets of triple superphosphate, which were to have been used at 2 per stand and compared with an equivalent dressing of 71 lb. superphosphate per acre. Actually only one pellet of triple (= 35.5 lb. p.a.) was used per stand whilst a dressing of 77 lb. powder was given. Pellets were dibbled $1\frac{1}{2}$ " from the seed at the time of planting and powder was laid in a thin line in a channel made at the summit of the ridge immediately prior to planting.

Three parallel strips, each $\frac{1}{5}$ acre, (1) No Manure, (2) Triple pellet, (3) Powder, were laid down on 20 farms between the end of June and the middle of August. On October 5th there was a noticeable increase in height due to the powder, but none due to triple. There was, however, a significantly greater number of flowers on all plots receiving phosphate : the increase due to triple was 39%, and that due to superphosphate 59%. Final yields of seed cotton were :—

No Manure	...	...	...	...	354 lb.
Triple Pellet (= 35 lb. Superphosphate)	...	...	...	...	402 „
Superphosphate powder (77 lb/acre)	...	...	...	...	446 „
Value of 77 lb. Superphosphate at £20 per ton	= 13/9d.				
Value of 92 lb. seed cotton at 4d. per lb.	= 30/8d.				

ENTOMOLOGY

by

Q. A. GEERING.

The programme of work during the past season was concerned with the survey of the extent of bollworm damage, and an assessment of the relative importance of all species, viz., *Diparopsis castanea*, *Platyedra gossypiella*, *Argyroplote leucotreta* and *Earias spp.*

Special attention was paid to the life histories of *D. castanea* and *P. gossypiella*, and stainer populations were also recorded. Observations were mostly confined to the Northern Allen belt, and the work was centred at Samaru. Additional records were obtained from two stations further north, at Gusau and Daudawa, and also at Kontagora on the south western edge of the Northern belt. Limited observations were made in the middle and Southern cotton belts. The report deals mainly with the work done at Samaru.

CLIMATE.

The cessation of the rains at the end of September resulted in a rapid fall in the relative humidity throughout October, and by early November *harmattan* conditions had set in and the humidity continued to fall. The sudden change in humidity is illustrated in Fig. 1. This shows the weekly mean of the daily mean (8 a.m. and 2 p.m.) percentage relative humidity at Samaru from August 26th, 1948, to May 31st, 1949. It is of interest to compare this graph with the shedding data and the recommencement of bollworm activity in 1949.

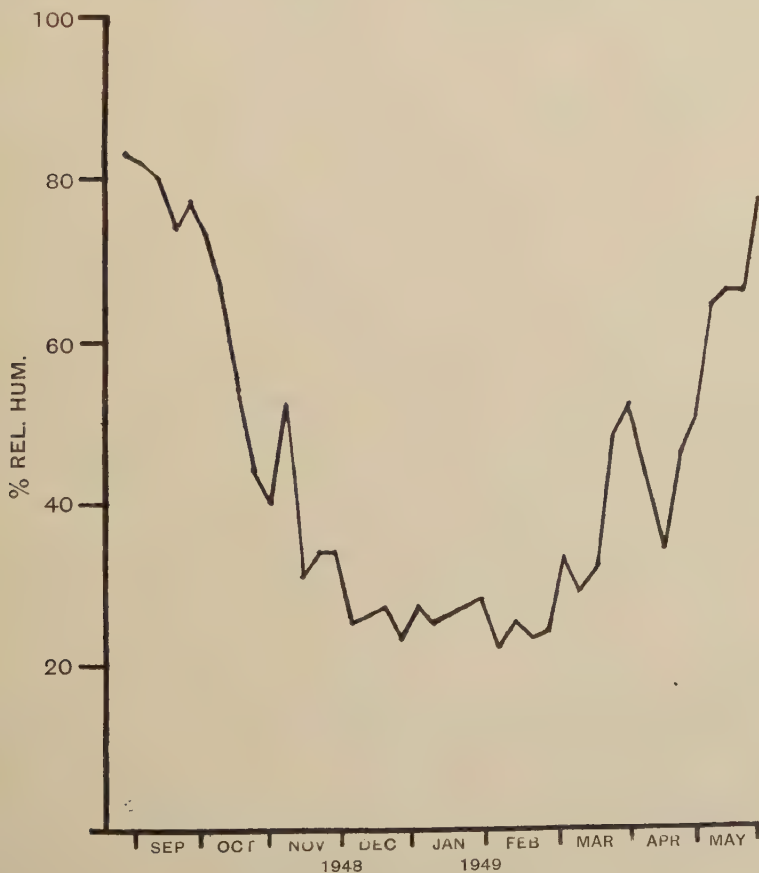


FIG. 1.—RELATIVE HUMIDITY : SAMARU 1948-49.

SEASONAL ACTIVITY OF PESTS, 1948-49.

(a) *Red Bollworm (Diparopsis castanea)* (Fig. 2).

Eggs of *Diparopsis* were first recorded in the crop on August 26th, and thereafter there appeared to be three phases of attack, showing peaks of oviposition in early September, at the end of October and in mid-November. Eggs were present in small numbers up to the end of December. The total population of eggs recorded throughout the season represented rather less than five per hole of two plants. Larvæ of *Diparopsis* were first recorded in samples during the second week of October, and the subsequent changes in larval population reflected the changes in egg numbers, but on a much lower level. No larvæ were recorded after 17th December. The peak of oviposition in mid-October did not produce a high proportion of shedding due to bollworm, and the subsequent peak in larval population was about one third of the maximum egg population. There thus appears to have been a high larval mortality, probably in the first instar.

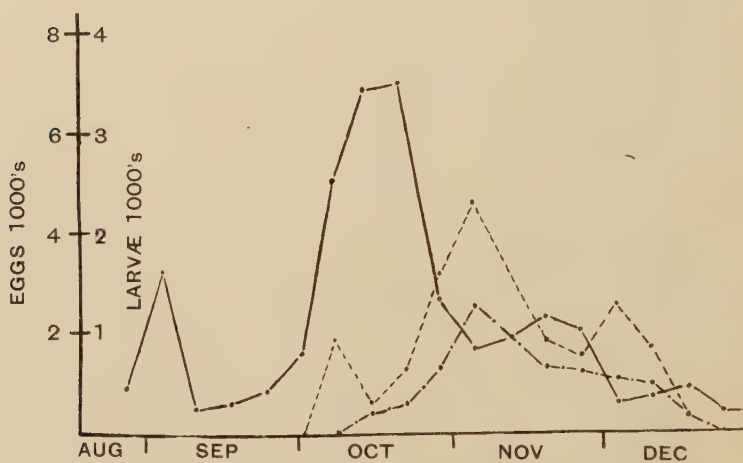


FIG. 2.—RED BOLLWORM POPULATIONS: SAMARU 1948.

—•—•—• EGGS/ACRE/WEEK. - - - - - TOTAL LARVÆ/ACRE.
 . —• —• . 5th INSTAR/ACRE.

In order to determine the annual flight period of *Diparopsis*, weekly collections of fully grown larvæ were made; these were placed in cages of perforated zinc in concrete troughs and subsequent emergence recorded. Full grown larvæ were collected from the first week of October to the middle of December. Between the middle and end of October the proportion of non short-term pupæ increased from 40% to 96.6%. All collections made after 14th November showed no short term pupæ, but Dipterous parasites continued to

emerge up to the first week of January. At the time of writing this report (September, 1949) emergence records were not yet complete, but the numbers of larvæ collected in 1948, and the moths so far produced are shown in the following table.

TABLE 1. ORIGIN OF MOTHS EMERGING FROM OCTOBER, 1948, TO END OF JULY, 1949 :—

Month of Collection.	Larvæ Collected.	Months of Emergence.					
		Oct.	Nov.	Dec.	Jan.	June.	July.
October	77	0	15	0	0	0	0
November	153	—	0	3	0	4	0
December	99	—	—	0	0	7	1

It will be seen that the majority of the pupæ at the end of July were either still in diapause, or had died. Those moths emerging in June and July will have produced two further generations of moths on ratoon and stand over cotton by the time the main crop is susceptible to attack.

Limited numbers of full-grown larvæ were collected during monthly visits to Kontagora and Gusau. Emergence from Kontagora larvæ was similar to that from the Samaru material, while larvæ collected (only in November) from Gusau have not yet produced any moths. In the Gusau area *Diparopsis* appears to breed over a very much shorter period than in all other areas and this probably accounts for its scarcity in that region.

(b) *Pink Bollworm (Platyedra gossypiella)*.

Larvæ were first recorded in bolls during the third week of October. The population showed two peaks of the order of 3,000 per acre and this figure was never appreciably exceeded. Any great increase in numbers towards the end of the season was apparently prevented by the progressive development of diapause. The population of diapause larvæ in the ripe crop at the end of the season was determined at Samaru and also at Gusau, where pink bollworm populations were very much higher. An assessment was then made of the numbers that were left in the field after harvest, and these are shown in Table II. At Gusau and Samaru they represented 13.2% and 22.2% respectively of the diapause populations.

TABLE II. PINK BOLLWORMS PER ACRE OCCURRING IN HARVESTED COTTON : GUSAU AND SAMARU, 1949.

	Removed at Harvest.		Left on Field (In Diapause).	Total Larvæ.	Total In Diapause.
	Total.	In Diapause.			
Gusau... ..	11,504	10,909	1,664	13,168	12,573
Samaru	2,711	2,350	677	3,388	3,027

The progressive development of diapause was followed at Samaru : most material was collected here and at Gusau. In addition, single collections were made in early December at Kontagora and at Ibadan.

All larvæ were kept in tubes at Samaru, and the proportions of larvæ in diapause over the whole period are shown in Table III.

TABLE III. PINK BOLLWORM: DEVELOPMENT OF DIAPAUSE.

Percentage of Larvæ in Diapause, 1948-49.

	Samaru.	Gusau.	Kontagora.	Ibadan,
11th to 24th October ...	0	4.7	0	—
25th October to 7th November ...	12.5	—	—	—
8th to 21st November ...	21.8	42.6	—	—
22nd November to 5th December ...	62.6	70.9	60.6	0
6th to 19th December ...	83.5	97.0	—	—
20th December to 2nd January ...	93.0	100.0	—	—
3rd to 9th January ...	100.0	100.0	—	—

At Gusau diapause set in earlier than at Samaru, while the condition of larvæ at Ibadan in early December was in marked contrast to the other areas.

The subsequent emergence of all diapause larvæ has been disappointing owing to an unusually high mortality caused by a parasitic mite. All diapause larvæ appeared normal and healthy until the middle of March; then, coincident with the sudden rise in humidity at the end of March and in early April, the majority of larvæ became infected with the mite which appeared within the tightly spun cocoons. The mite attacked larvæ whether these were in tubes in the open insectary, or placed in cotton seed, or in cages at different depths in a seed store, or on the surface of pupation trays. The general occurrence of the mite under all these different conditions suggests that it might be a natural enemy, and that the abnormal concentration of larvæ under all conditions of our experiments, favoured its increase and spread. All dead larvæ occurring in samples collected from a seed store were carefully examined, but only 1% of these could be definitely classified as killed by mites. The small number of diapause larvæ which survived pupated and produced moths over the period from February to May. A more general picture of the fate of diapause larvæ was obtained from additional observations made during the first seven months of 1949.

In the first place an estimate was made of the proportion of diapause larvæ removed during ginning: this was obtained by counting larvæ in samples of seed cotton entering the gins, and re-counting in samples of seed coming out. At four ginneries the percentage removal varied from 36.6 to 100%, with an average of 71.6%. The general level of seed infestation was then studied by examining a large number of seed samples from the principal ginneries in the northern belt. The results showed a wide variation in total infestation and in larvæ per unit sample.

The average infestation of live larvæ per 10 lb. seed for six ginneries was: Kontagora 0.9, Funtua 3.0, Malamfashi 3.1, Bauchi 6, and Zaria 10.3 (one sample only from Gusau gave a figure of 14). The mortality of the total larvæ present in the same samples was

Kontagora 84.5%, Funtua 72.8%, Malamfashi 79.4%, Bauchi 86.6% and Zaria 54.4%. Thus the gins effectively reduced the numbers of the diapause larvæ, by removing them from the seed and causing a high mortality in those which remained in the seed. The fate of these larvæ under seed store conditions was then followed: this entailed regular collection of seed from a store containing 300 tons of seed at Zaria ginnery. Samples were taken from the beginning of March, and up to the end of July there did not appear to be any increase in mortality of the larvæ. From the beginning of June there was a marked reduction in the number of the living larvæ present, and at the end of July living larvæ per 10 lb. seed were 1.3 as compared with 13 in March. Pupæ appeared at intervals over the whole period, maximum numbers being present during April and May.

The fate of larvæ left on old cotton plants was followed by taking two-weekly samples of damaged bolls remaining on the stand over cotton plants at Samaru. Samples were taken from May to July, and over the whole period pupæ were recorded, maximum numbers occurring in early June. At the end of July no larvæ, but only pupæ were present.

In normal years the main cotton crop in the northern belt is in a susceptible stage for bollworm attack from the middle of August onwards. The emergence from diapause larvæ collected in 1948 has not been completely satisfactory, but the observations on seed infestation and old bolls in the field indicate that by the end of July the majority of diapause larvæ have either produced moths or died. Samples of seed sown on plots in July 1949 were examined and in none were living pink bollworms found. The carry-over of the species from one season to the next on a large scale seems therefore to depend on either the survival of moths during August, or their early breeding on ratoon and stand over cotton. Observations on this latter point indicate that this plays a considerable part in enabling the moth to breed up in the July-sown cotton.

(c) *Spiny bollworms* (*Earias insulana* and *E. biplaga*).

Oviposition by *Earias* started at about the same time as *Diparopsis* but continued much later and on a considerable scale throughout the dry season. Larvæ of these species were the first to be recorded, and in the middle of January, after the crop had been harvested, spiny bollworms numbered 1,297 per acre; these were breeding on small bolls being produced by the semi-senescent plants.

(d) *False Codling Moth* (*Argyroplote leucotreta*).

This species appeared to have a much shorter period of breeding in cotton than the other bollworms. Larvæ were first recorded in mid-October and had disappeared by early December; the peak of infestation occurred in the third week of November.

(e) *Cotton Stainer* (*Dysdercus supersticiosus*).

The only species encountered on cotton was *Dysdercus supersticiosus*. At Gusau, Daudawa and Samaru adults appeared in the crop at the end of September before any ripe bolls were present. At Samaru all stages were scarce throughout the season. At Daudawa peak numbers of adults occurred in early October and then rapidly disappeared. Fifth instar nymphs then appeared in early November, having bred on the first split bolls; as soon as these nymphs matured they left the crop. The same cycle of activity appeared to occur slightly earlier at Gusau, and three weeks later at Kontagora.

CROP LOSS.

(a) *Shedding*.

The main data on shedding were obtained at Samaru on the Botanist's two permanent rotation plots: at the same time the development of the crop was followed, and the results are presented graphically in Fig. 3. Shedding of buds commenced in the first week of September a few days after the first eggs of *Diparopsis* were recorded. Only during the two following weeks was the proportion damaged by bollworm high (88.9% and 73.32%). Thereafter the proportion of shed buds damaged by bollworm did not exceed 48%. Boll shedding began during the last week of September, and from then onwards the majority of sheds collected were bolls; the proportion of these damaged by bollworm did not exceed 39%, and averaged 20.1%. The two peaks of shedding occurred in early October and early November, but on neither occasion was the increase associated with a high proportion damaged by bollworm. If Fig. 1 is consulted it is seen that these peaks occurred at times when there was a sudden decrease in the relative humidity of the air. The flowering curve shows a steep rise to a peak on the 20th September and flower production then declined and was probably greatly influenced by the sudden cessation of the rains. The majority of shedding thus occurred after the peak of flowering but at a time when the main crop of bolls should have been set. A comparison of the shedding and the bolling curves in Fig. 3 indicates that boll setting was delayed and prolonged by the heavy shedding (mostly bolls) in early October and again in November. Consequently many of the later-formed bolls did not mature. It thus appears that shedding caused indirectly a considerable loss of crop, but it cannot be said that bollworms were mainly responsible for this result, which seems to be more adequately attributed to the sudden change in climate.

(b) *Damage to bolls not shed*.

The damage occurring in the whole of the crop which did not shed was determined on the plots at all stations. With the exception of Gusau where the cotton was thinned to one plant per hole, all plots grew two plants per hole. The results from Daudawa are not representative of the whole crop since one picking was taken before our sampling began.

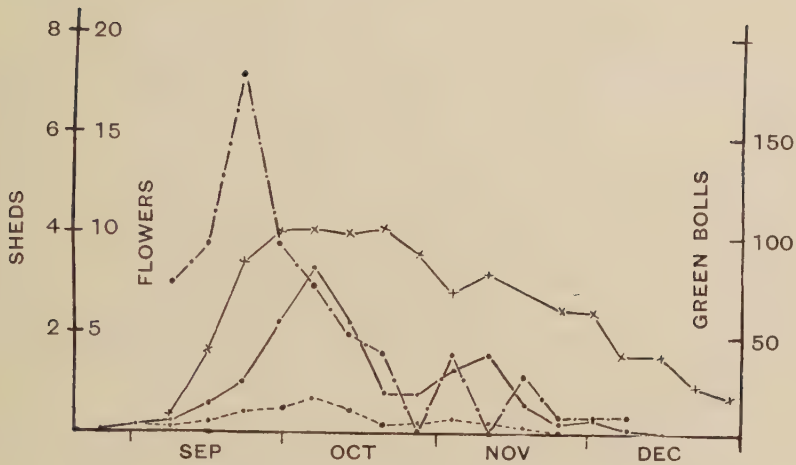


FIG. 3.—FLOWERING, BOLLING AND SHEDDING : SAMARU 1948.

ALL FIGURES IN 1000'S PER ACRE. —•—• FLOWERS. —•—• TOTAL SHEDS.
 •—•—• B. W. SHEDS. —X—X GREEN BOLLS.

TABLE IV. % LOCK DAMAGE IN BOLLS NOT SHED.

	Samaru.	Gusau.	Daudawa.	Kontagora.
Lb./acre Grade 1 Seed cotton ...	503	272	316	245
Clean ...	74.9	50.2	75.3	45.9
Bollworm ...	11.0	18.2	6.0	8.9
Non-bollworm, partial loss ...	10.3	22.8	11.4	26.0
Non-bollworm, complete loss ...	3.8	8.8	7.3	19.2

NOTE.—The locks classified as "non-bollworm, partial loss" were those in which lint had developed, though this was partly or completely stained. The locks classified as "non-bollworm, complete loss" were those either completely shrivelled, or with the partially developed lint browned and matted together. Both classes include damage attributable to cotton stainers.

The proportion of damage attributable to bollworm is surprisingly low, particularly at Kontagora where in the area as a whole bollworms, particularly *Diparopsis*, appeared to be doing considerable damage. The cotton here was grown on the groundnut experimental farm which was not in the main cotton area of Kontagora and this may have accounted for a reduced bollworm attack. Large populations of stainers were recorded here and at Gusau and in these instances appear to have effected most damage. At Gusau, which showed the highest bollworm damage, the dominant species was *P. gossypiella*.

(c) Survey of the principal cotton growing areas—November, 1948.

A rapid survey was made during November in each of the following areas : Gusau, Daudawa, Funtua and Malamfashi, Samaru, Kontagora, Ibadan and Oyo province. Some information was also obtained from the central middle belt, in Benue.

The areas sampled in the Northern belt showed all species of bollworms present. Populations of individual species in each area varied considerably in the different fields examined. Considering the average total of damaged bolls per acre encountered, the N. Benue region showed most with 47,800 per acre, then Kontagora with 24,600 per acre, then Gusau 11,300 per acre, Daudawa, Funtua and Samaru of the same order, and 7,000—8,000 per acre, and S. Benue showing the least, 5,600 per acre.

The survey showed fairly clearly that in the Northern belt damage by *Argyroplote* occurred consistently but was never excessively heavy and always of secondary importance. *Earias* showed a similar consistency in the Northern area, but was sometimes dominant and caused heavy damage. *Diparopsis* and *Platyedra* showed variation from major to minor importance.

The results from the Middle Belt suggest conditions were especially favourable for *Diparopsis*, *Platyedra* and *Earias*. *Argyroplote* was probably not important.

In the Southern belt, during the early part of the season, *Platyedra* was dominant, *Diparopsis* and *Earias* were of minor importance, and *Argyroplote* was not present. Damaged bolls averaged 7,900 per acre, indicating that later attack must have been severe.

BOLLWORM ACTIVITY ON RATOON AND STANDOVER COTTON, 1949.

At Samaru in order to determine the earliest recommencement of bollworm activity after the end of the dry season, cotton was allowed to stand over; one plot was also ratooned in early February, i.e. the plants were cut back to within 6 in. of ground level. This type of ratooning is rarely met with: the ratoons which do occur throughout the northern cotton belt arise from plants which are cut back to ground level, and then grow again because they are not cut at a sufficient depth below the soil surface to be killed. In the middle belt a commoner practice is to allow the plants to stand over without any cutting back.

On the standover cotton at Samaru *Earias* was the only active species from February to the end of May. Egg laying continued on a considerable scale up to the middle of March, but the larval population was limited by the small number of bolls produced by the plants. During April and May oviposition was sporadic and on a small scale and ceased during June; larvæ, which were absent over this latter period, reappeared in early July.

Diparopsis activity recommenced at the end of May when eggs were first recorded on 30th. Egg laying increased during June and rose to a peak of 7,000 per acre in early July. Larval populations again reflected on a smaller scale the changes in egg numbers. The first moths bred in the standover crop emerged at the end of July. Larvæ of *Platyedra* reappeared at the end of June and by the end of July the population just exceeded 500 per acre. *Argyroplote* was the latest species to recommence breeding on the cotton, and reappeared in the middle of July. The population of this species showed a rapid rise to 1,500 per acre by the end of July.

On the ratooned cotton the different species recommenced activity in the same order as on the standover cotton, but on a much smaller scale. This was entirely due to the smaller number of ratooned plants which survived the dry season, and to the smaller size of the surviving plants.

In certain areas of the Northern belt ratoon cotton plants occur extensively. Daudawa is a typical example, and here counts were made of ratoons in mid-July. The numbers per acre varied from 100 to nearly 1,800, and *Diparopsis* egg numbers ranged from 160 to over 5,000 per acre. Larvæ of *Diparopsis* predominated, and small numbers of *Platyedra* and *Earias* were also present. This situation is regrettable but is apparently unavoidable since the hard nature of the soil and the implements available do not enable the old cotton plants to be even adequately cut back during the dry season. In order to overcome this difficulty a number of uprooting tools of the type used by the Sudan Plantations Syndicate will be distributed in the Daudawa area next January. In this way it is hoped to ensure a thorough uprooting of all old plants within a 2 mile radius of Daudawa and to study the effect of this on bollworm populations.

SUMMARY.

The survey has shown that in the past season no single species of bollworm was entirely responsible for the damage inflicted on the crop in any area. At Gusau, the most northerly area examined, half of the bollworm damage was attributable to *Platyedra* and half equally attributable to *Earias* and *Argyroprocte*. Of the loss attributed to insect damage, the major portion appeared to be due to stainers and associated internal boll disease. At Kontogora, at the southern extreme of the Northern belt, *Diparopsis*, *Platyedra* and *Earias* were responsible for most of the bollworm damage. Here again stainers appeared to cause more damage and loss of quality in the crop. In the intermediate zone of the northern belt no single species tended to predominate, but most damage was probably caused by *Diparopsis* and *Earias*, these being the two larger species. A clearer picture of the status of all species in the middle and southern belts will be obtained in the coming season.

The main conclusion that can be drawn from only one season's observations is that a properly enforced close season in the Northern belt would undoubtedly have some controlling effect on *Diparopsis*, *Earias* and *Platyedra*. The proposed attempt to ensure complete uprooting in the Daudawa area should indicate how effective this can be. The possible limits of a close season have yet to be determined and will largely depend on the results of the studies on the flight period of *Diparopsis*.

PROGRAMME FOR 1949-50.

The recording of bollworm and stainer populations and studies of *Diparopsis* emergence will continue at all stations in the Northern Belt and at Ibadan in the Southern Belt. At Samaru all future records will be taken on the Botanist's permanent rotation plots, and on a plot farmed according to local practice. Plots at all stations will be allowed to stand over through the dry season in order to determine the dates of recommencement of bollworm activity. Records will also be made of the incidence of white fly and any occurrence of virus disease. Attention will also be paid to the proposed uprooting measures in the Daudawa area.

At Daudawa preliminary insecticide trials will be conducted to test the efficacy of dusts and sprays. These will include DDT dusts, wetttable powder and emulsion sprays with and without Gammexane ; a 20% Toxaphene dust ; and an ICI mixture containing DDT, Gammexane and Sulphur. Treatments will be tested on early and normal dates of sowing.

PROGRESS REPORT ON COTTON IN THE WESTERN PROVINCES OF SOUTHERN NIGERIA FOR THE SEASON 1948-49.

BOTANICAL SECTION.

Work at Ibadan on Ishan " A " cotton followed the usual every other year basis of selection, that of establishing 16 progeny row trials from the highest yielders of the eight strains tested for yield in the previous year and selecting the best eight rows on the basis of halo length and ginning percentage.

The growing season was abnormally dry, the rainfall in the four months July-October totalling 12.34 inches as against a mean figure of 23.57 inches for the same months in the five previous years. The poor rainfall, coupled with attacks of *Helopeltis* and bollworm, caused a low average yield of 63.6 lb. per acre. About 0.05 % of the plants which suffered an attack of leaf curl disease were rogued and burnt before flowering.

The figures for halo length and ginning percentage of the selfed seedlings in the progeny rows were as follows :—

Progeny Rows.	Ginning Out-turn.	Halo-length (mms.)
A 1	34.6	30.5
A 3	32.4	31.3
A 4	32.4	30.0
A 9	32.2	29.9
A 11	33.6	30.0
A 12	32.6	30.5
A 14	33.4	29.5
A 16	32.2	30.5
A 2	32.8	29.8
A 5	32.6	29.5
A 6	32.6	28.8
A 7	31.6	29.5

<i>Progeny Rows</i>	<i>Ginning Out-turn</i>	<i>Halo-length (mms)</i>
A 8	33.6	29.1
A 10	32.8	29.3
A 13	32.6	29.6
A 15	32.0	28.5
Mean ...	32.8	29.8

The first eight were selected for 8 by 8 yield trial this year.

ENTOMOLOGICAL SECTION.

Insecticidal Control of Helopeltis on Cotton.

E. O. Pearson, in his "Report on a visit to Nigeria" (1947), observes that peasant cotton, grown under early partial shade, appears to suffer less from attack by *Helopeltis* than does cotton grown in pure stand. An experiment was accordingly conducted to compare the effects on *Helopeltis* attack and on yields of spraying with DDT and of providing partial shade, as against no treatment. As this experiment was of an exploratory nature, DDT was applied on three occasions in 5 % suspension, which is probably an uneconomic rate. The following four treatments were compared:—

(i) No treatment; (ii) sprayed: no shade; (iii) unsprayed, shaded; (iv) shaded, sprayed.

All plants grown under the shade of early maize suffered severely from water shortage and growth was very poor until the maize matured. *Helopeltis* injury was not particularly severe on these plants but total growth was much less than that of plants grown in the open. Plants grown without shade and not subjected to spray treatment were very severely attacked by *Helopeltis*, while *Helopeltis* injury was light on those which had been sprayed.

The maximum numbers of insects per plant recorded during the season were as follows:—

(i) Unshaded, unsprayed	...	3.2
(ii) Unshaded, sprayed	...	0.2
(iii) Shaded, unsprayed	...	1.2
(iv) Shaded, sprayed	...	0.9

Yields of cotton lint and seed differed markedly according to treatment and were as follows:—

<i>Treatment.</i>	<i>Lint (lb/acre).</i>	<i>Seed (lb/acre).</i>
(i)	13	14
(ii)	35	53
(iii)	7	7
(iv)	5	10

A yield of seed cotton amounting to only 88 lb. per acre, which was the highest yield obtained, cannot be regarded as satisfactory and it is evident that some factor other than injury by *Helopeltis* was also limiting yields. Nevertheless the experiment demonstrates that control of *Helopeltis* by means of insecticide is definitely possible and that a definite and substantial increment in yield is obtained when the pest is controlled.

Observations made on trial plots of Ishan "A" cotton planted at different places in the forest belt of the Western Provinces showed that the incidence of *Helopeltis* attack was slight compared with the heavy attack which invariably occurred in the unwooded areas.

WEST INDIES.

COTTON EXPERIMENT STATIONS.

INTRODUCTORY NOTE

BY

J. V. LOCHRIE.

COMMERCIAL CROP.

The M.S.I. variety of Sea Island cotton is produced under two different planting seasons: Antigua and Nevis planting the crop in September–October and Montserrat and St. Kitts in March–April. The acreage planted to this variety increased by 60% over last season's figure of 7,300 acres; the largest increases came from Antigua and Nevis while St. Kitts returned to normal production after a poor year due to labour troubles and to somewhat indifferent planting conditions. Climatic conditions were better than those of the previous two seasons and, in addition, there was increased interest in the crop due to satisfaction with the prices offered and particularly to the fact that prices were known in advance of planting.

In actual production the increase in M.S.I. was even greater than that in acreage being about 72% over the preceding year. This was due in great measure to the very successful season in Antigua, where the 3,500 acres planted gave the highly satisfactory average yield of 260 lb. lint per acre in a year of low insect pest losses. This happy condition did not apply in all Islands as Nevis yielded only 100 lb. per acre—of which some 40% was stained—mainly as a result of heavy pink bollworm attack. Pest control is of the highest importance and a greater degree of efficiency is needed in maintaining a proper close season and so ensuring that the clean up in fields and buildings is thorough.

The superfine crop doubled its acreage to 4,000, the bulk of this being the V.135 variety in St. Vincent. There was some reduction in yield due largely to the failure of the January rains which caused boll shedding on late planted cotton. In spite of this the production of superfine showed an increase of 33% over the previous season. Pest damage was low and it is encouraging to note that concern over the re-establishment of stainer host plants has been followed by a campaign by the Agricultural Department and estate owners for their destruction.

The prospects for the coming season indicate that the superfine acreage will be maintained, but there is a slight reduction in M.S.I. due to a heavy drop in the Nevis acreage.

In addition to the effect of conditions at planting the cotton acreage is influenced by the economics of the crop compared with competing agricultural products. This is particularly so in St. Vincent where arrowroot and groundnuts are grown satisfactorily and command good prices.

EXPERIMENT STATIONS.

On the Antigua Station the rainfall was higher than in the preceding seasons and the distribution fairly satisfactory. It is pleasant to record that insect pests were not serious with the result that the Station crop averaged around 500 lb. lint per acre.

Under the very different conditions of a favourable and pest free season with high yields the manurial trials gave results very similar to the earlier dry years. Again potash gave no response and evidently this is not a limiting factor here. The cotton close season was again one of low rainfall and the lack of response to early application of nitrogen is due to the build up of nitrate in the soil. With phosphate and with pen manure increases in plant growth and in yield were again obtained.

Investigations on systems of land use continued to provide useful information. The poor result from weed fallow in the close season was again evident compared with bare fallow. The main effect was in delaying growth and fruiting and the longer cropping season this year allowed the cotton after the weed fallow to make a good recovery.

In the rotation trials there was ample evidence that high productivity of elephant grass can only be maintained by fairly heavy manuring. Also when the land is returned to arable cropping temporary nitrogen deficiency has to be corrected either by a term of bare fallowing or by the application of nitrogenous fertilizers.

On the Montserrat Station work on the maintenance of the M.S.I. variety continued on the usual lines and pedigree seed was supplied to the various Islands growing this cotton. Conditions were good and the crop was established early.

Potash is not at present a limiting factor and manurial trials are now confined to trials of nitrogen and phosphate in various rates of application on different soil types. The indications this season corroborate those of other years and show agreement with the analyses of the soils. There is now sufficient evidence to show that nitrogenous manuring can be profitable on the lighter soils. On the other hand, on the Shoal type soils, where drainage is impeded and where total nitrogen is higher, there are encouraging responses to phosphatic manures.

Some pen manure and cotton seed meal are available and the present trials show their value in increasing yields.

On the St. Vincent Station the V.135 selection and seed renewal scheme was carried out along the usual lines and, in addition, further progress was made with the VH8 hybrid material. Spinning tests on

VH8 progenies gave very high figures for yarn strength, those of the 4602 strain in particular being stronger than the V.135 progenies this season. In a combined manurial and variety trial the VH8 material gave substantial increases in yield over V.135 due in some part to its higher ginning outturn. A bale of lint of the VH8 variety is now being tested under mill conditions and the results will be valuable in assessing the future of the variety.

On these soils the value of nitrogenous manures has been amply demonstrated and the trials this season show that application of coconut and cotton seed meals gave the same result as similar amounts of nitrogen applied as sulphate of ammonia. A further trial of various levels of N : P : K showed that phosphate was not a limiting factor. Increases in sulphate of ammonia over the usual recommended application of 300 lb. per acre showed some depression in yield. There was a significant effect of potash, the highest yield being obtained from an application of 150 lb. of muriate of potash in combination with the standard application of 300 lb. sulphate of ammonia.

COTTON EXPERIMENT STATION, ANTIGUA.

PROGRESS REPORT FOR THE SEASON 1948-49

BY

J. V. LOCHRIE AND J. R. SPENCE.

INTRODUCTION.

The season was the most successful in the history of cotton growing in the Island. The acreage planted was 3,500, the highest except for the two years 1940-41 and 1941-42, and gave the very satisfactory average yield of about 250 lb. clean lint per acre. The factors contributing to this were the good and reasonably well distributed rainfall and the high degree of freedom from insect pests. The Station crop averaged 500 lb. lint per acre compared with one third of this in the previous season.

General information on the season is given in Table 1.

TABLE 1.

<i>Seasonal Data.</i>	<i>Commercial Crop.</i>	<i>Experiment Station.</i>
Close Season	1st June to 31st August.	Same.
Planting period	September to October.	2nd to 16th September.
Picking period	February to May.	February to April.
Rainfall	Year ending 31st May, 1949.	41.47 ins.
Mean max. temperature	Year ending 31st May, 1949.	83.8°
Mean min. temperature	Year ending 31st May, 1949.	73.9°

The Station continued under the same organisation and with the same staff as in the previous seasons. Mr. Lochrie was on leave until October, 1948, and Mr. Spence for a short period towards the end of the year. We have to acknowledge the ready co-operation of the Agricultural Department and of the various land owners who placed land at our disposal and also of the Imperial College of Tropical Agriculture, particularly the Department of Chemistry and Soil Science, for advice and assistance.

For the first time we are able to record that insect pests were not of any considerable importance. Leafworm appeared early but was controlled by spraying. Greenbug was in numbers only in one outside experiment while pink bollworm infestation was light until the end of the season and damage was severe only on late planted crops.

The main work of the Station is directed towards investigation of the manurial requirements of these soils ; of farming practices ; and of systems of land use with the view of improvement of soil fertility and the intensification of production. Under the very different conditions of a favourable season and high yields the results from manurial trials followed very closely those of the previous dry years. Increases

in plant growth and yield were again obtained from small applications of pen manure and from superphosphate. Sulphate of ammonia gave no response when applied early and the lack of any response to applications of potash is in line with previous experiments and with the indications from chemical analyses of these soils.

The soil is easily worked and of free drainage, and cultivation and weeding trials indicate that thorough cultivation is of little importance compared with the value of good and early weeding.

The present system of agriculture consists almost entirely of the cultivation of sugar or cotton for export. The presence of food crops on peasant holdings may constitute some casual change of crop but there is no planned rotation and continuous cotton growing is common. Sugar cane tops provide a seasonal supply of extra stock food in the cutting period but the production of forage is foreign to stock owners. If stock keeping is to increase and have any considerable influence on soil fertility and on supplies of animal products, at present mainly imported, a more intensive system of feeding by the use of planted grasses of high productivity will be necessary. Information is needed on the productivity and persistence of grasses; their response to manuring; their influence on succeeding arable crops; and on methods of returning grassland to arable cultivation.

In the present rotation trials the yield of elephant grass decreased in the second year after planting but the response to manuring was greater and indicates that a higher rate of nitrogenous fertilisers would be needed for high productivity. Difficulties might be expected in returning elephant grass land to arable cultivation and investigations have started to determine the time required between the ploughing out of the grass and the planting of cotton. Under conditions here it is evident that five months, the longest period tried, is not too long as cotton yields decreased with each shortening of the bare fallow period.

The experiment on the use of land during the cotton close season was again interesting. The results followed the same trend as those of the previous season with cotton following a weed fallow showing delayed early growth. In yield, however, the superiority of a bare fallow treatment was much less marked owing to the higher rainfall and longer season.

METEOROLOGY.

The monthly rainfall and temperature figures are given in Table 2, *A.* being the rainfall for 1948-49 and *B.* the average over 30 years.

TABLE II.

	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	Total.
<i>A.</i> ...	4.19	1.54	2.42	3.94	4.99	6.44	3.46	1.40	2.15	5.80	3.01	2.13	41.47
<i>B.</i> ...	3.82	3.74	4.43	4.77	5.22	5.35	2.86	2.38	1.62	1.54	2.04	3.27	41.04
Mean Max. ...	86.7	87.0	87.2	86.7	85.2	83.8	81.4	80.1	80.1	81.0	82.8	83.7	
Mean Min. ...	76.2	77.1	76.9	76.5	75.2	74.8	73.5	70.0	69.6	70.9	72.3	73.6	

The total of 41.47 in. for the year is about average for the Station area and the distribution was fairly satisfactory. The close season was dry and this was reflected in rather poor growth of maize and other

crops then on the land. The main features of the season were the rather difficult period for plant establishment following the light rains of August and early September, and the favourable conditions for plant growth and crop development later. January and February were dry and the crop opened quickly and cleanly, while the rains of March were too late to contribute to the crop. Had these rains been earlier flowering would have held on longer but it appears likely that any gain in this way would have been offset by the loss of late bolls in the rapid build up of pink bollworm at the end of the season.

AGRICULTURE.

Manuring.—The commercial cotton crop is unmanured except for the application of such small amounts of pen manure as may be available. The investigations on kinds and amounts of fertilisers and on times and methods of application were continued.

An NPK trial of $3 \times 3 \times 3$ design was carried out on the Station on a calcareous clay typical of the soil type on which the great bulk of the commercial cotton crop is grown. Rates of application were reduced to about half of those of the previous season; sulphate of ammonia at 150 and 300 lb. per acre; superphosphate at 250 and 500 lb.; and sulphate of potash at 75 and 150 lb. In addition to the reduction in the rates the method of application was changed. Superphosphate and potash were incorporated in the ridges 2 weeks before planting and the sulphate of ammonia applied in 2 doses—one half at thinning and the remainder before the start of flowering. It has to be noted that the trial was repeated on the same site as that of the previous season and thus residual as well as direct effects are involved.

Potash gave no response in growth or yield and this corroborates the results from earlier trials and shows agreement with the data from soil analyses. Similarly, nitrogen showed no effect, and it seems clear that the build-up of nitrate in clean cultivated land here during the cotton close season is ample for the crop under these conditions. It is worth noting that with the rates and times of application of sulphate of ammonia used there was no depressing effect on plant growth such as was seen in the previous season. Phosphate again gave considerable increases in plant growth and yield, as shown in Table 3, but there was no further response to the double application and it appears that very high rates are not needed under these conditions.

Now that fertilisers have been applied for two seasons it is proposed to use the layout to measure residual effects.

TABLE III.

Treatment.	Plant weights as % of P_0 .		Yield as % of P_0 seed cotton.
	Days from planting.		
	26	55	
P_0	100.0	100.0	100.0
P_1	131.0	156.0	121.0
P_2	134.0	160.0	118.0
Significance	—	—	8.3 at 5%.
Mean yield over the trial—2,060 lb. seed cotton per acre.			

Residual Effects.—The residual effects of high fertiliser rates were measured on the site of an N.P.K. trial which had direct applications in the 1947–48 season. The site was on the Government Experiment Station and the soil is a heavier clay and of poorer drainage than the Station soils. The cotton crop yielded well in the dry conditions of the 1947–48 season but there was no response to the application of manures. Since then two successive crops—maize and cotton—have been reaped and no yield response from the residual value of high fertiliser applications has resulted. The cotton crop yielded 2,000 lb. seed cotton per acre and it is evident that this heavy Gunthorpe clay is capable of producing good crops without added manure.

Phosphate.—In view of the evidence of response to superphosphate on this calcareous soil, a trial with a wide range of rates was planted. The applications increased by increments of 200 lb. from nil up to 800 lb. per acre, and these were applied both in the presence and absence of sulphate of ammonia. Yields were good, the unmanured series giving over 1,500 lb. seed cotton per acre, and there was no response to phosphate beyond that of the 200 lb. application. This confirms the conclusions from other trials, viz., that increased yield may be expected from 200 lb. superphosphate but that nothing is to be gained by increasing the rate. Again there was no response to early applications of sulphate of ammonia under conditions of clean cultivation in the close season.

A further trial comparing the placing of superphosphate under the seed with broadcasting and working the fertiliser into the ridge showed no differences in growth or yield. So far the lowest rate of superphosphate used in trials here has been 200 lb. per acre and in view of the possibilities of returns from small placed applications it is proposed to investigate the effects of a range of rates from about 25 lb. per acre.

Nitrogen.—Times of application of sulphate of ammonia were investigated in a split plot layout with the phosphate treatments occupying the subplots. A standard rate of 200 lb. sulphate of ammonia was used and applied: (A) all at 2 weeks after planting; (B) at 5 weeks and (C) at 8 weeks.

TABLE IV.

	Yields in lb. seed cotton per acre.				
	No. N.	(A)	(B)	(C)	Means.
P. present	1,670	1,800	1,950	1,620	1,760 } C.D. at 5% 1,500 } 104 lb.
P. absent	1,550	1,320	1,600	1,570	
Means	1,610	1,560	1,780	1,590	

C.D. at 5% for times of application of N. 145 lb.
C.D. at 5% for interaction 202 lb.

The main features of the trial are :—

- (1) the beneficial effect of P., particularly in the presence of sulphate of ammonia applied at 2 and 5 weeks after planting.
- (2) the success of the application of N. at 5 weeks.

- (3) the evidence of a depressing effect of early application of sulphate of ammonia in the absence of phosphate, confirming that reported last season.

A few manurial trials were planted on estates. Treatment effects were small, particularly on the deeper soils, but the results followed the pattern seen on trials on the Station where close season bare fallowing is practised. Responses to N. as artificials were nil but increases were obtained from superphosphate and from pen manure.

Pen Manure.—The trial described in the last two reports was continued on the same site using pen manure equivalent on analysis to 19.4 lb. N., 22.4 lb. P_2O_5 , and 30.5 lb. K_2O per ton. The pen manure made on the Station is low in P_2O_5 and, in view of the response to phosphate, the P_2O_5 content was increased by the addition of superphosphate to the manure during the rotting down process. The treatments were (1) 2 tons pen manure per acre; (2) 4 tons; (3) 6 tons; (4) artificials with equivalent N.P.K. to 2 tons pen manure; and (5) an unmanured series. In addition to a lowering of rates of application compared with previous years, changes were made in the time of application, artificials being applied in the ridges before planting as in the case of the pen manure. Also, instead of there being a bare fallow in the close season, a maize crop was grown but, under conditions of limiting moisture, the crop was small and gave no indication of residual manurial effects.

The cotton crop got away well and, as before, treatment differences were early apparent as is shown by the tabulated data of growth samples taken (a) at thinning and (b) just before flowering.

TABLE V.

Treatments.	Growth as % of (5).		Flowering % of (5)	Yield in lb. seed cotton	
	(a)	(b)		per acre.	% of (5).
(1)	131.1	152.4	112	1,670	113.8
(2)	116.2	159.2	117	1,816	123.7
(3)	123.0	170.0	126	1,678	114.3
(4)	112.2	140.8	111	1,610	109.7
(5)	100.0	100.0	100.0	1,468	100.0
C.D. at 5% ...	17.2	19.8	—	196	13.3

The trial gave results very similar to those of the two previous years of shorter seasons and lower yields. Pen manure at all levels gave significant increases in growth and yield but there are indications that the lowest rate used this season—2 tons per acre—was on the low side. The failure of the highest pen manure treatment to carry its growth and flowering superiority to the yield stage was due to an attack of "Chibble Leaf." This became noticeable in early January in this treatment and was reflected in a falling off in yield in the later pickings.

Artificials alone—188 lb. sulphate of ammonia, 224 lb. superphosphate, and 125 lb. sulphate of potash—gave lower responses in growth and flowering and the yield increase was not significant.

It is clear from the 3 seasons of this trial and from results on other sites that yield increases may be expected from pen manure and,

further, that small applications are quite satisfactory thus allowing a wider spread of the available supplies. As the manures have now been applied for 3 years it is proposed to measure residual effects in the coming season.

A weeding and cultivation trial was carried out on the Station. The soil is a calcareous clay but lightened by up to 40 per cent. carbonate of lime ; it is free working and of good drainage. The results showed no advantage in thorough cultivation over no cultivation provided that weeds are controlled. Early weeding was shown to be the most important factor and clearly showed its advantage in the better plant growth.

LAND USE.

The experiments on farming systems described in previous reports were continued.

Rotation A.—The treatments, and the reasons for their inclusion, were described last year, but for easy reference they are repeated here. The object is to see the effects on subsequent cotton crops and on soil fertility of (1) 3 crops of cane—plant cane and 2 ratoons ; (2) elephant grass for the same period ; (3) a periodic break in cotton growing by a full year's rest in a green manure crop ; and (4) continuous cotton as is the common practice. The sugar cane and elephant grass were planted in May, 1947, and the present report covers the second year of these crops. The trial includes both an unmanured series and one receiving a heavy basal dressing of superphosphate at the beginning of the rotation and with sulphate of ammonia applied at intervals during the year.

The yields of the various crops is given below in lb. per acre ; (a) manured, and (b) unmanured.

TABLE VI.

<i>Elephant Grass.</i>			<i>Sugar Cane.</i>			<i>Cotton.</i>		
(a)	(b)	<i>Increase.</i>	(a)	(b)	<i>Increase.</i>	(a)	(b)	<i>Increase.</i>
58,667	46,329	+26.5%	33,150	38,940	—15%	2,171	1,871	+16.0%
C.D.	Significant at 1%.		Non significant.			Significant at 5%.		

The increase in grass yield due to manures has risen from 21 per cent. in the first year to 26 per cent. in the second, but it is important to note that the actual grass yields have dropped sharply in spite of a year of higher rainfall. The falling off is due in part to the loss of one cutting by heavy attack of caterpillars (*Remigia sp.?*) but the pronounced "picture frame" effect with poor growth inside even the manured plots indicates nutrient deficiency. It would appear that the amount of sulphate applied—a total of 370 lb. for the year applied after each cutting—is not sufficient to maintain high productivity where the grass is removed for stall feeding.

Cotton yields were high and the percentage increase from manuring is the same as in the previous season. With sugar cane there was a decrease in yield but this was not statistically significant.

The soil structure was examined periodically and the plots under grass show a considerable rise, compared with those under cotton, in the proportion of crumbs over $\frac{1}{2}$ mm.

Grass Fallow.—The poor early growth of cotton following short term weed fallows has been noted in earlier reports and it is clear that information is needed on methods of handling grassland when it has to be brought back to arable cropping after a term of years. The present experiment on elephant grass compared the following treatments, both unmanured and with applications of 200 lb. of sulphate of ammonia.

- (1) Cultivated in April and planted in maize in the close season.
- (2) Cultivated in April and bare fallowed.
- (3) Cultivated in June and bare fallowed.
- (4) Cultivated in August.

The elephant grass was cut and removed as forage and the trial is thus not comparable with the digging under of the complete plants.

Cotton and maize were used as indicator crops and both were planted in mid-September and the sulphate of ammonia was applied to half plots—half at planting and half at thinning. The site of the trial proved rather unsatisfactory but in spite of this lack of uniformity some useful information was obtained. The data, from whole plots, are summarized in Table 7.

TABLE VII.

Treatment.	Cotton.			Maize.	
	Germination as % of (4).	Growth % of (4) 75 days.	Yield lb. per acre.	Growth % of (4) 33 days.	Yield in lb. grain per acre.
(1)	125	238	1,080	216	1,657
(2)	126	296	1,392	320	1,885
(3)	120	165	1,243	204	934
(4)	100	100	911	100	892
C.D. at 5% ...	6.8	108	223	83	660

Germination was retarded where cotton was planted soon after the breaking up of grassland, and the growth and yield of both crops decreased progressively with the shortening of the fallow period. The maize crop planted in the close season in (1) cropped poorly and reduced the yields of the following crops, and under these conditions it is clear that a considerable period in bare fallow is needed.

A surprising feature was the poor response to the sulphate of ammonia, especially in (4), where deficiency of available nitrogen would be expected to be acute. Further trials with various rates of sulphate of ammonia applied to the buried residue as well as to the following crop are planned.

Rotation B.—The trial, which was continued on the same site as in the previous season, investigates methods of using the close season period. The treatments are (1) maize grown for grain; (2) a green manure crop; (3) bare fallow and (4) a weed fallow,

The close season was dry but the maize and the green manure crop (cowpeas) were well established by the end of May. The maize made a small crop somewhat similar to that of the previous season but the growth of weeds and of the green manure was heavier. By mid-August the maize was harvested and the stalks removed, while the weeds and the green manure were buried in the ridges. In the manured series 200 lb. of sulphate of ammonia per acre were added to the buried residues at this stage and a similar amount was applied to the maize and bare fallow treatments in two doses—half at 3 weeks from planting and half 4 weeks later. Cotton was planted in early September.

TABLE VIII.

Close Season Treatment.	Growth % of Weed Fallow		Flowering % of Weed Fallow.	Yield of seed cotton	
	42 days.	66 days.		lb. per acre.	% of Weed Fallow.
Maize ...	100.0	113.7	98	1,642	92.4
Green manure ...	131.3	138.9	104	1,917	107.9
Bare Fallow ...	171.4	151.4	101	1,887	106.2
Weed Fallow ...	100.0	100.0	100	1,777	100.0
C.D. at 5% ...	21.3	18.5	—	175.3	9.3
Manurial effect ...	N.S.	at 1%	—	at 5%	—

TABLE IX.

YIELD ANALYSIS AS % OF EACH TREATMENT TOTAL. CUMULATIVE INDEX AT EACH PICKING.

Treatment.	1st	2nd	3rd	4th	5th
Maize ...	8.1	23.8	48.2	84.0	100
Green Manure ...	9.8	24.6	46.7	80.9	100
Bare Fallow ...	13.0	29.6	53.3	84.0	100
Weed Fallow ...	6.1	17.2	39.9	77.9	100

Again the trial shows striking increases in plant growth following bare fallow, and to a lesser extent green manure, but this year the superiority is not carried through to yields. The present season was one of higher and better distributed rainfall and this, and the comparative freedom from pink bollworm, resulted in a longer picking season.

It was suggested last year that the large increase in early growth of cotton after bare fallow was due to nitrate accumulation in the close season being readily available for the plants, while in the case of weed fallow and green manure nitrate was being utilised in the decomposition of plant residues. That the differences in early growth were not reflected in yield this year may be explained by the more rapid decomposition of residues and subsequent nitrification in the better rainfall conditions. The crops following the weed fallow and the green manure treatments were able to take advantage of this in the favourable season and to finish well.

The growth figures and the yield analysis by pickings show the delaying effect of weed fallow on crop production and stress what may happen in a cropping season shortened by poor climatic conditions or by pest attack. Weed fallow has the further disadvantage of

making land preparation and subsequent weeding heavy and expensive. Bare fallowing gives the plants the advantage of a quick getaway but this effect may be lost to some extent in seasons and soils where heavy rains around planting cause leaching of the accumulated nitrate, and in addition it tends to leave the soil open to erosion and to a gradual depletion of soil organic matter and nitrogen. Leguminous green manures appear to break up rapidly, and this may prove the best system, particularly where some sulphate of ammonia is applied to the residues at the time of ploughing under.

Land Re-habilitation.—In the last report it was recorded that considerable amounts of shallow soils exist on hillsides in the calcareous clay region and that pressure on the land is forcing these areas into cultivation. These soils have been subject to severe erosion through cultivation in the past and are of little depth. Investigations have been started to see how productiveness may be maintained by soil and water conservation methods, the use of manures, and by crop treatments ranging from permanent grass for cutting as forage through temporary grass leys to continuous arable cropping.

No evidence of rotation effects will be available for some years but information of value is already being indicated. Guinea grass appears well suited to these hillsides and is giving very encouraging responses to manuring in the form of a basal dressing of phosphate and applications of sulphate of ammonia at each cutting. As regards cash and food crops which may be suitable for inclusion in a rotation, it is clear that sugar cane is not successful, but reasonable crops of cotton and maize can be grown and the response to manuring is considerable. Whatever form of cropping may be used it is necessary that adequate measures be employed to conserve rainfall as well as soil.

COTTON STRAINS.

The type collection and variable bulks of Sea Island strains were maintained on the lines of previous years.

In view of any possibility of changes in trade demand necessitating replacement of the M.S.I. strain in some of the Islands, and to bring information up to date on agricultural and technological qualities, a start was made in the bulking up of some of the more promising strains. The co-operation of the Antigua Syndicate Estates Ltd. has been obtained and it is proposed to carry the bulking of some half dozen strains a stage further by planting them as isolated plots in fields of sugar cane. This will make possible a series of strain trials in the different Islands.

Quality of M.S.I.—It is recognised that the quality of M.S.I. grown in Antigua and in Nevis is somewhat lower than that grown from the same pedigree seed supply in Montserrat and St. Kitts, being of higher hair weight and of lower yarn strength. There are no indications that the differences are due to soil type or soil fertility but it is significant that the higher quality islands plant the crop in March-April while the others plant in September-October. Owing

to the pink bollworm position and the difficulty of obtaining sites far from cultivated cotton the influence of planting season cannot be determined by a series of planting dates in the open and small plots in an insect proof cage have had to be resorted to. The Spinning and Hair Test Reports on the first series of samples show differences in yarn strength and in fibre weight ; the October planting giving figures at the usual Antigua level while April and July plantings give values more in line with those obtained from Montserrat cotton which is planted around March-April. The trial is being continued.

PESTS AND DISEASES.

Pink Bollworm (Platyedra gossypiella).—Owing to the very dry close season a carryover of the pest in the soil was feared and early examination was made of crops on the Station and outside. At the start of flowering in mid-November floral infestation of 10 to 20 per cent. was found and a quick build up was feared. This did not materialise, and the main pickings were clean, but at the end of the season the pest increased greatly. As usual the late crop suffered and this stresses the importance of getting the whole crop established as soon as possible after the planting season opens.

It is worth noting that the characteristic symptoms of floral infestation—puffing of infested flowers with imbrication of the tips of the petals—described by Squire in the West Indies—were no criterion of the degree of infestation here as only a small proportion of affected flowers showed this condition. The attacked flowers were fairly easy to detect as they showed a “ felting ” of the stamens around the feeding larvæ.

Leafworm (Alabama argillacea).—Attacks started in the very young stages of the crop and control measures by spraying with lead arsenate started in late September and were necessary at intervals up to December. The early infestations are important, causing stunting of the young plants, and early identification and prompt control measures are essential. Control is a matter of routine in the industry but it adds considerably to the cost of production.

Stainer.—As in earlier years the pest was of little importance. One or two broods were seen on the Station at the end of the season and isolated cases of late infestation in the south of the island.

Greenbug (Nezara viridula).—No attack occurred on the Station this season, and the trial of various sprays and dusts gave no results of value owing to the small numbers of the insect. A fairly heavy infestation developed on a field of cowpeas adjoining an out-Station cotton experiment. As the cowpeas dried off counts showed a migration into the cotton, which was dusted with Toxaphene (chlorinated camphene). There was a fall in numbers in subsequent counts and a heavy attack did not develop. However, there were no undusted plots for comparison and it is not possible to assess the value of the dust in control. The only severe infestations observed this season were in areas where beans and tomatoes were grown.

It was reported last year that biological control of the pest was to be tried by the introduction of *Trichopoda pennipes* from the U.S.A. It was not found possible to carry out the project in time for this season but arrangements have been made for its implementation in the coming season by Dr. Simmonds of the Commonwealth Bureau of Biological Control.

“*Chibble Leaf*.”—This is the first time since the Station opened that this abnormal condition of plant growth and development has been apparent. The disease has been described by Nowell in his “Diseases of Crop Plants in the Lesser Antilles.”

The disease was observed in three localities. On the Government Experiment Station it occurred on a heavy clay soil of fair depth where the cotton crop was planted after a recent ploughing up of elephant grass. At Yeptons estate the cotton had been planted on old sugar cane cambered beds after the digging under of a heavy weed growth, and it was noteworthy that the plants on the deeper soil in the centre of the beds were most affected, with normal plants occurring on the shallow soil at the edges. On the Station the disease was much less marked, and occurred only on a pen manure trial with affected plants confined to the treatment receiving the highest applications of pen manure during the past three seasons. It was characteristic that the disease occurred in the period of wet and cloudy weather and the return to normal with high flowering was marked when dry, sunny conditions occurred in January. In all three cases observed the affected cotton was growing in exposed situations.

In affected plants the internodes of the main stem and vegetative branches were elongated but not particularly slender and the number of nodes on the sympodia were reduced with the first internode elongated. In contrast to healthy plants those affected were very tall, flowering had practically ceased and flower buds had dried up and blackened at a very early stage.

A characteristic feature was the distortion of the leaves. Nowell described the leaves as being strongly crimped around the margins and as being thin in substance and pale green in colour. In the cases now observed the leaf symptoms were somewhat different and agreed more closely with Phillis's description (Unpublished) of the disease seen by him on a heavy soil of rather indifferent drainage in Montserrat. Mature leaves were thick and rather irregular in shape and strikingly dark green in colour.

PROGRAMME FOR 1949-50.

Fertiliser investigations on the various soil types will be continued both on direct and residual effects. Responses to phosphate have been obtained at the lowest rate so far used and it is desirable to continue the trials with still lower rates and with various methods of applying the fertiliser.

The various land use trials will be continued and the grass fallow investigation will be continued and expanded to see how the bare fallow period may be shortened.

The maintenance of the type collection and variable bulks of Sea Island strains will be continued and the seed bulking of promising strains will be carried a stage further. In order to bring information on the agricultural and spinning qualities of the main strains up to date a number of trials will be planted in Antigua and where possible in the other Islands.

The caged plots of M.S.I. with plantings corresponding to those of the various Islands will be carried on to supplement the information so far obtained.

[Included by courtesy of the Government of the Leeward Islands.]

COTTON BREEDING STATION—MONSERRAT. PROGRESS REPORT FOR THE YEAR 1948.

BY

A. S. HARPER.

GENERAL INFORMATION.

	<i>Island Crop.</i>	<i>Breeding Experiments.</i>
Legal Close Season	15th December to 7th March	—
Sowing dates	7th March to 15th May	11th March.
Picking dates	July to October	12th July to early September.

The Station continued to function as a breeding station and central depot for seed for the Leeward and other Islands, under the guidance of Mr. J. V. Lochrie, Cotton Officer, West Indies. Manurial trials were continued on various estates.

METEOROLOGY.

Heavy showers in early March resulted in good germination and a uniform stand throughout the island. Rainfall in April was scant but the plants held on and with the coming of heavy showers in May grew rapidly. In June rainfall was satisfactory and later, with the exception of a few heavy showers before and during the first week of picking, which caused a small percentage of Black Bolling, weather was ideal. Rainfall distribution over the cropping period March—October for the Breeding Station at the Grove in the Leeward side of the island, Bethel in the Windward side, and Brades in the North was as follows:—

	<i>March.</i>	<i>April.</i>	<i>May.</i>	<i>June.</i>	<i>July.</i>	<i>Aug.</i>	<i>Sept.</i>	<i>Oct.</i>	<i>Total ins.</i>
Cotton Breeding Station	6.66	2.43	7.05	5.65	7.25	5.29	5.02	6.61	45.96
Bethel	3.44	1.34	4.81	3.13	3.15	3.57	3.76	7.31	30.51
Brades	3.85	1.13	6.73	2.98	4.35	5.13	4.03	8.99	37.19

The island's crop was good, being 633,708 lb. clean lint, giving a yield of 184 lb. to the acre.

COTTON BREEDING WORK.

Selection work was carried out as usual on twenty progeny rows grown from twenty plants selected from sixteen of the 1947 progenies. These were grown non-replicated and seed and lint characters were determined in the laboratory.

This was supplemented by a small bulks trial consisting of eight bulks grown in eight randomised blocks. Statistical analysis of the data from this trial reveals significant differences in lint yield and lint index. Bulk MB.4811 of the ancestor M.4210 was the lowest yielder this season and last year was the lowest yielder of the bulks of progenies which were carried on this season.

Other comparatively low yielders were bulks MB.4817 and MB.4819, which also had comparatively low lint indices. Bulk MB.4802 of ancestor M.4208 had a high seed weight and bulk MB.4813 a high ginning percentage.

Seed cotton characters for the trial are given in the following table :—

1948 Bulk.	1947 Progenies.	Seed weight per 100 seeds.	Ginning Out-turn.	Lint Index.	Yield per acre.
		<i>gms.</i>	<i>%</i>	<i>gms.</i>	<i>lb. lint.</i>
MB.4802	M.4703 and 04 ...	13.07	30.84	5.82	476.44
MB.4811	M.4705 and 06 ...	12.88	30.43	5.64	454.89
MB.4813	M.4709 and 10 ...	12.84	31.13	5.78	499.13
MB.4814	M.4711 and 12 ...	12.87	31.04	5.79	501.39
MB.4815	M.4713 and 14 ...	12.83	30.68	5.69	537.69
MB.4816	M.4715 and 16 ...	12.93	30.60	5.70	483.24
MB.4817	M.4717 and 18 ...	12.49	30.59	5.49	460.56
MB.4819	M.4719 and 20 ...	12.80	30.41	5.58	458.29
Means.		12.84	30.715	5.686	483.95
Levels of Significance		N.S.	N.S.	*	**

Samples of lint were sent from the progeny rows to the Shirley Institute for spinning tests and pending receipt of the data the majority of the progenies will be carried on.

Multiplication of Selected Seed.—Seed from selected progenies planted nearly six acres of first multiplication cotton and this produced an abundant supply of pedigree seed for planting the 1949 second multiplication area.

Distribution of Seed to neighbouring Islands.—The following quantities of pedigree seed were shipped to neighbouring islands during the year : Nevis, 300 lb. ; St. Kitts, 100 lb. ; Antigua, 180 lb., and Tortola 50 lb.

In addition the following quantities of planting seed were supplied :—29,630 lb. to Antigua, 12,608 lb. to St. Lucia, 11,252 lb. to Nevis, 4,460 lb. to Puerto Rico and 360 lb. to Tortola, making a total of nearly sixty thousand pounds of planting seed shipped.

NP EXPERIMENTS.

The NP experiments on the four major soil types were continued and responses to nitrogen obtained on the Fresh Ash, Brown Earth and Shoal soil types, and to phosphate on the Brown Earth and Shoal soil types.

The nitrogenous and phosphatic applications were applied by sprinkling by hand in a ring about 3 in.—4 in. around the base of the plant. This was carried out about four weeks after planting except in one case, that of superphosphate on the alluvial soil type, where application was made earlier, about two weeks after planting. The pen manure in the shoal trial was applied one week before planting.

In the experiments on Fresh Ash, Shoal, Brown Earth and Alluvial soils :—

N1 = Ammonium Sulphate at the rate of 200 lb. per acre.

N2 = " " " 400 " "

P1 = Superphosphate " 200 " "

P2 = " " 400 " "

The results of chemical analysis for available phosphate carried out at the Imperial College are in agreement with the results of the manurial trials in that increases from superphosphate have been obtained where chemical analysis has given low values for phosphate—on the Shoal and Brown Earth Soils 21.5 and 66 p.p.m. No responses were obtained on Alluvial and Fresh Ash Soils which chemical analysis showed to have 178.5 and 292 p.p.m. phosphate respectively.

An appreciable increase in yield was obtained from ammonium sulphate on the Fresh Ash Soil which chemical analysis showed to be deficient in nitrogen, but on the Alluvial Soil, also chemically deficient in nitrogen there was a slight depression in yield due to the application of ammonium sulphate. The Shoal and Brown Earth Soils, which laboratory analysis showed to have just about adequate quantities for cotton, gave slight increases (12 per cent.—16 per cent.) to this manure.

Fresh Ash Soil.—The trial was carried out at Richmond Estate. Scorching of the foliage by ammonium sulphate, aphid attack in various spots in the early stage and later cotton leafworm attack hampered the progress of the experiment. Treatment totals in lb. per acre are as follows :—

		P ₁	P ₂	P ₃	Mean.
N ₀	...	992	1,030	1,100	1,041
N ₁	...	1,280	991	1,135	1,135
N ₂	...	912	1,231	869	1,004
Mean	...	1,061	1,084	1,035	1,060

Statistical analysis showed no significant differences due to nitrogenous or phosphatic applications but the F value for interaction was significant for P = 0.05. The lower rate of application of nitrogen (200 lb. an acre ammonium sulphate) has however given, as in previous years, the highest increase in yield, 29 per cent. over the control, an increase of 300 lb. an acre, and this when applied without the addition of phosphate. Seed cotton yields from this treatment over the three years were as follows :—

Year.	Yield Control Plots. (lb. per acre.)	Yield N ₁ P ₀ Plots. (lb. per acre.)	Increase in Yield. (lb. per acre.)	% Increase.	Price per lb. Lint.	Gross Increase per acre. (Approx.)
1946	1,337	1,445	108	8%	2/-	£3
1947	1,817	2,238	420	22%	2/6	£16
1948	990	1,280	290	29%	3/2	£13

Responses to superphosphate and higher application of ammonium sulphate have not been marked in any year.

Trials comparing ammonium sulphate with cotton seed meal, the manure generally used on this estate, are indicated.

Brown Earth Soil.—The site of this experiment was changed from Tuitts in the Windward side of the island to Amersham in the Leeward side, and the experiment was planted on April 5th about one month after the opening of the planting season. Germination was good and final stand fairly uniform from plot to plot. There was no noteworthy incidence of pests and disease. (Manures were applied one month after planting.) Yields of seed cotton in lb. per acre were as follows :—

					P ₀	P ₁	P ₂	Mean.
N ₀	...	...	...	...	775	899	874	849
N ₁	...	...	...	...	920	975	895	930
N ₂	...	...	...	...	927	925	1,161	1,004
Mean	...	...	...	...	874	933	977	927

Though differences failed to reach statistical significance every treatment showed an increase over the control. Highest increases were obtained where both manures were used in combination in equal quantities, the N₂P₂ treatment being the highest, 50 per cent. (or 387 lb. per acre) over the control and the N₁P₁ next, being 26 per cent. over the control.

Shoal Soil.—The trial on this soil type was simplified by the elimination of the double doses of nitrogen and phosphate and the inclusion of a pen manure treatment and was carried out on peasant lands on Cork Hill. Pen manure was applied at the rate of about 8 tons an acre.

			O	N	P	NP	PM	Mean.
Yields lb. per acre...	...	...	504	564	840	738	706	670
% Increase	...	...		16%	66%	46%	40%	

There was an increase in yield from all treatments, the highest increase being obtained from phosphatic applications alone applied at the rate of 300 lb. an acre.

Alluvial Soil. The trial this year was carried out on Richmond Estate. Plot yields in lb. per acre were as follows :—

					P ₀	P ₁	P ₂	Mean.
N ₀	...	...	...	...	881	974	879	911
N ₁	...	...	...	...	768	879	688	778
N ₂	...	...	...	...	734	773	792	766
Mean	...	...	...	...	794	875	786	819

There was an appreciable depression in yield due to the application of ammonium sulphate—probably the result of scorching of the foliage in the early stages, and, later, of heavier infestation of cotton leafworm on nitrogenous manured than on non-nitrogenous manured plots.

Phosphate was applied earlier in this experiment than is customary, 13 days after planting, and it is worthy of note that the P₁ plots have given an increase of 10—11 per cent. over the control plots.

In 1946 ammonium sulphate at the lower rate of application gave an increase of 34 per cent. over the control plots in the trial on this soil type at Trants.

Observation Experiment.—A trial to compare the effect of artificials, pen manure and the local cotton seed meal was laid down on alluvial land at Delvins, situated at the base of a shoally hill. An

attempt was made to equalise the amount of nitrogen present in the three treatments. From chemical analysis carried out by Prof. F. Hardy the amounts of nitrogen, phosphate and potash in pen manure and cotton seed meal compared with artificials were as follows:—

	<i>Total lb. per acre.</i>	<i>N</i>	<i>P lb. per acre.</i>	<i>K</i>
Ammonium Sulphate	150	30.9	—	—
Superphosphate	300	—	54.0	—
Cotton Seed Meal	600	27.34	8.52	—
Pen Manure	17,360	34.72	26.86	17.79

Yields in lb. per acre were as follows:—

	<i>O</i>	<i>N</i>	<i>P</i>	<i>NP</i>	<i>PM</i>	<i>CSM</i>	<i>Mean.</i>
Yield	914	1,210	990	1,150	1,192	1,440	1,150
% Increase	—	33%	9%	27%	31%	72%	—

All treatments gave yields higher than the control, cotton seed meal being the highest with an increase of 72 per cent., with ammonium sulphate next closely followed by pen manure. The phosphate treatment gave the small increase of 9 per cent.

The soil is by no means typical of the rest of the island but the results do give some indication of the effects of the different manures. The superiority of the CSM over the pen manure treatment may be accounted for by the availability of the nutrients of this manure over the pen manure, and repetition of the trial is indicated.

Rotational Trial.—The cotton in the rotational trial suggested in last year's report was planted in March and the cane and grass in April. Preparation of land for cotton was carried out at the same time in January, 1948, and no results with regard to weed following during the close season were therefore expected. All the plots have been divided into two sub-plots for the inclusion of a pen manure *versus* no pen manure treatment. Results from this trial in the case of cotton were not significant and treatments will be repeated.

ACKNOWLEDGMENT.

The writer is indebted to those planters who assisted in the work, to the Chemistry Department of the Imperial College for analysis of the samples, to the senior staff of the Department of Agriculture for their suggestions and criticisms and to F. A. Horner, Clerk, for assisting in the collection and analysis of the data.

PROGRAMME FOR 1949.

1. The Breeding trial will be continued.
2. The NP trials on Fresh Ash and Brown Earth Soils will be repeated.
3. The Observation trial at Delvins will be repeated.
4. The Rotational trial at Amersham will be continued.

[Included by courtesy of the Government of the Windward Islands.]

CAMDEN PARK EXPERIMENT STATION, ST. VINCENT.

PROGRESS REPORT

ON THE

COTTON BREEDING WORK

FOR THE SEASON 1948-49.

BY

H. S. McCONNIE.

GENERAL INFORMATION.

	<i>Island Crop.</i>	<i>Experiments.</i>
Sowing dates	15th August to 30th September ...	16th September to 15th October.
Picking dates	December to February	January to March.
Legal close season	1st May to 14th August	

STAFF.

Mr. W. R. E. Nanton left the Colony in August, 1949 to take up an appointment as Cacao Agronomist in Grenada; the duties of Officer-in-Charge are being temporarily performed by the writer. The majority of the paragraphs under the section headed "Manurial Trials" have been taken directly from a Progress Report prepared by Mr. Nanton on the research work of the Station for the past five years.

WEATHER CONDITIONS AND PESTS.

Suitable weather conditions prevailed throughout the season and resulted in a good stand at germination with very good yields of lint. The season was remarkably free from insect pests and diseases, and no control measures whatsoever were necessary. A small number of plants died from wilt but this was not confined to either the VH.8 or the V.135 varieties and was not noticed in any particular area.

BREEDING PROGRAMME.

The breeding work was similar to that of the 1947-48 season and will be discussed under the following heads :—

- (a) The V.135 seed renewal scheme.
- (b) Work with VH hybrid material.

V.135 Seed Renewal Scheme.

As in former years, sixteen progenies were grown in the 1948-49 season from sixteen plants selected from the previous season's progeny rows. The selections were based on characters which were measured locally and on spinning test results.

The usual yield and seed cotton characters were measured and selection of parents for the 1949-50 season made on these in conjunction with the results of the 1948-49 spinning tests. The spinning test results showed that the yarn strength was somewhat lower than in previous seasons and selections were made to incorporate parents of highest yarn strength in the 1949-50 progenies.

The V.135 breeding material of 1947-48 bred true to type and no progeny was rejected. All selfed seed not required for progeny row work was therefore sown to provide the first stage of multiplication of the island's supply of planting seed.

The second stage of multiplication was carried out entirely at Diamond Estate. Seed obtained was of good quality and the yield was sufficient to meet the island's requirements for 1949-50.

Work with VH Hybrid Material.

Main Breeding Trial.—This trial was used to compare twenty-four VH.8 progenies with a representative V.135 progeny. The progeny chosen for comparison was V.4725.

The main trial was laid out as a 3 (5×5) lattice square design, each plot comprising 6 plants spaced $1\frac{1}{2}'$ on a 4' ridge.

As a result of the very strong pressure exerted in previous seasons in selection for better spinning values, very interesting and encouraging results were returned in the spinning test report from the Shirley Institute. Only 5 of the 24 VH.8 progenies were of lower yarn strength than the V.135 included in the trial for comparison. This in turn was superior in yarn strength to the majority of the V.135 progeny row material. The results may be summarised below as follows:

CORRECTED LEA COUNT X STRENGTH PRODUCTS.				
(a) <i>Main Breeding Trial</i> —				
Mean of all VH progenies in the trial	...	...	...	2869
Strongest VH progeny	...	...	...	3229
Weakest VH.8 progeny	...	...	...	2669
Commercial V.135 included for comparison	...	...	...	2772
(b) <i>V.135 progeny rows</i> —				
Means of all V.135 progeny row material	...	...	...	2705
Strongest V.135 progeny	...	...	...	2904
Weakest V.135 progeny	...	...	...	2547

Should these results be repeated in the 1949-50 season it would then be reasonably safe to state that a cotton hybrid has been produced which is equal to, or superior to the V.135 variety with regard to yarn strength.

In selecting material for the 1949-50 breeding work a compromise was made between strength of yarn and high yielding families of VH.8, so as to preserve the gains already made in both these characters. The selections are summarised in Table I.

TABLE I.
SUMMARY OF DATA—VH TRIALS 1948-1949. (*Weight in grams.*)

<i>Strain.</i>	<i>Family.</i>	<i>Lint per Plot.</i>	<i>Ginning Out-turn.</i>	<i>Seed Wt. 100 seed. Gm.</i>	<i>Seeds per Boll.</i>	<i>Bolling Index.</i>	<i>Yarn Strength.</i>
VH.4601	VH.4701	298	29.02	13.2	16.1	333	2776
	VH.4704	275	29.18	13.4	15.7	318	2856
Mean ...	—	287	29.10	13.3	15.9	326	2816
VH.4602	VH.4705	260	27.78	13.6	15.4	337	2906
	VH.4707	286	28.09	13.7	15.2	351	3012
	VH.4708	229	27.70	13.5	14.7	300	3094
Mean ...	—	258	27.66	13.6	15.1	329	3004
VH.4621	VH.4718	239	26.16	12.7	16.4	330	2753
	VH.4719	242	25.89	13.0	15.7	346	2775
	VH.4720	207	25.81	13.2	15.4	293	2833
Mean ...	—	229	25.95	13.0	15.8	323	2787
Mean for all VH Progenies ...	—	258	27.57	13.3	15.6	326	2868
—	V.135	256	24.96	13.1	15.5	394	2772

Small Bulk Trial.—This trial was used to compare the bulked progenies of the families contributing to the current year's breeding material in a small plot latin square experiment. To provide for a more suitable comparison V.135 commercial planting seed was used.

A statistical analysis of the data was not carried out but from an examination of the mean lint yield per plot, two of the five VH families fell slightly below the yield of the V.135 material, although the mean for all VH plots was 8% higher than the mean of the V.135.

Valuation of VH Cotton.

A bale of VH.8 cotton was grown from the best VH material available and shipped to Thos. Oliver & Sons, Manchester, England, for valuation. The results of their report are anxiously awaited.

MANURIAL TRIALS.

Organic versus Inorganic Manurial Trial with Cotton.

A pilot experiment using a 3×3 latin square with plot size of 180 sq. ft. was designed to compare the effect, on cotton, of a 200 lb. dressing of sulphate of ammonia with the nitrogen equivalent in cotton seed meal and coconut meal.

Negligible amounts of phosphoric acid and potash, less than 2%, were found in the samples of meal, and, in view of the results of previous experiments, the rates per acre proposed were not considered as warranting the addition of P and K to the sulphate of ammonia treatment. The following treatments, approximately equivalent as regards their nitrogen contents were tested and compared.

Sulphate of Ammonia	...	...	...	...	200 lb. per acre.
Cotton Seed Meal	...	...	...	...	900 " " "
Coconut Meal	...	...	...	...	1,200 " " "

The plots were planted on the 23rd September, and the manures applied on the 18th October, 1948. Growth and condition generally were good. The first picking was made on the 1st February, 1949, and

the crop completely harvested four weeks after that date. The mean yields of the treatments are given below in lb. seed cotton per acre :

Sulphate of Ammonia	...	...	...	...	1,027 lb. per acre.
Cotton Seed Meal	...	...	...	...	1,020 " " "
Coconut Meal	...	...	...	...	1,020 " " "
Significant Difference	...	...	...	...	97.7

The coefficient of variation of the trial was small, 5.85%, and the trial may therefore be taken as having a high degree of precision. It is clear that no difference whatever existed between the three treatments.

High Level NPK and VH versus V.135 Cotton Manurial Variety Trial.

The $3 \times 3 \times 3 \times 2$ factorial design, described by Yates, was used to test three levels of N, P and K. For the fourth factor it was decided to compare the new cotton hybrid, VH.8, with the standard V.135 commercial variety. Blocks of six plots and two complete replications were used to give 108 plots in all. The "Z" design was employed. The crop was planted on the contour on 4 ft. ridges and spaced 18 ins. apart on the ridge. The ridges marked the boundaries between the plots.

The same site and layout had previously been employed to test 3 levels of N, P and K and to compare two arrowroot varieties. The plots, of course, were supplied with the same kind of manure in the trial under discussion.

The soil type of the site is considered representative of the nitrogen deficient soils of St. Vincent for which it had been confirmed that a dressing of 300 lb. sulphate of ammonia could profitably produce increased yields of cotton. The three levels of sulphate of ammonia tested were 300 lb., 600 lb. and 900 lb. It could therefore be said that a basal dressing of 300 lb. sulphate of ammonia per acre was applied to all plots.

Previous trials on this soil had shown the depressing effects of small quantities of phosphate. As the trial was mainly designed to study the effects of heavy phosphate dressings, the no phosphate level was also omitted. Superphosphate was applied at the rate of 300, 600 and 900 lb. per acre.

The results following manuring with potassic fertilizers had always appeared erratic and at times conflicting. The three potash levels were therefore represented by : none, 150 and 300 lb. muriate of potash per acre.

The trial was planted on the 6th September, 1948, and a good stand was obtained. Manures were applied on the 8th October, 1948. Weather conditions were favourable and no pests or diseases were observed in the plots. Reaping was done on the 3rd February and the 9th March, 1949. After ginning the weight of lint was recorded for each plot.

Results.—The analysis of variance was drawn up to show the main manurial and variety effects separately and also the interactions between the fertilizer ingredients and those between manures and varieties.

Varietal Effects.—As was to be expected the hybrid was far superior to V.135. The difference was of the order of 71 lb. of lint per acre or 24%. Both varieties reacted in essentially the same manner to the manurial treatments as is evidenced by the non-significance of the variety-manurial interaction. Increasing doses of phosphate progressively depressed the yields of VH.8 while having little or no effect on V.135, but this result was not statistically significant. It is however worthy of note.

Manurial Responses.—The overall effect of the heavier dressings of phosphate was to depress yields though not significantly, indicating that lack of phosphate was not a limiting factor in this trial. Further, no manurial interaction involving the phosphate factor was of the slightest significance.

The responses to nitrogen and potash were of great interest, and the revelant data, free from confounding, are given in the 2-way table which follows :

MEAN YIELDS FOR PLOTS RECEIVING VARIOUS COMBINATIONS OF SULPHATE OF AMMONIA
AND MURIATE OF POTASH (*lb. lint per acre*).

	Muriate of Potash			Mean Nitrogen Effect.
	None.	150 lb. per acre.	300 lb. per acre.	
Sulphate of Ammonia 300 lb. per acre ...	302	366	329	332
" " " 600 " " " ...	267	326	346	313
" " " 900 " " " ...	277	292	342	305
Mean Potash Effect	282	328	341	—
Significant differences—				
Main effects			29.8 lb. per acre.	
Individual combinations			59.8 " " "	

It will be seen that the main effect of sulphate of ammonia was to depress yields. Potash on the other hand was responsible for important and significant yield increases. The analysis of variance revealed that the "I" component of the $N \times K$ interaction was significant indicating that the response to one of the fertilizers was dependent on the quantity of the other. The "J" component did not however show significant differences. Thus when 900 lb. of sulphate of ammonia was applied along with 150 lb. muriate of potash, the mean yield of lint was 29 lb. less than would be expected had the two factors acted independently. In all other combinations of nitrogen and potash no interaction of significance was observed.

Discussion.—The soil on which the trial was conducted had been analysed for its nutrient status and found to be deficient in nitrogen, medium low in phosphate and fairly rich in potash. Over the previous three years the nitrogen, phosphate and potash plots of the experiment, then under arrowroot, had received varying doses of these ingredients. In the year immediately preceding, relatively massive doses of nitrogen and phosphate had been applied to the respective plots. It is not unlikely therefore that there was an appreciable residual effect in the case of these two factors.

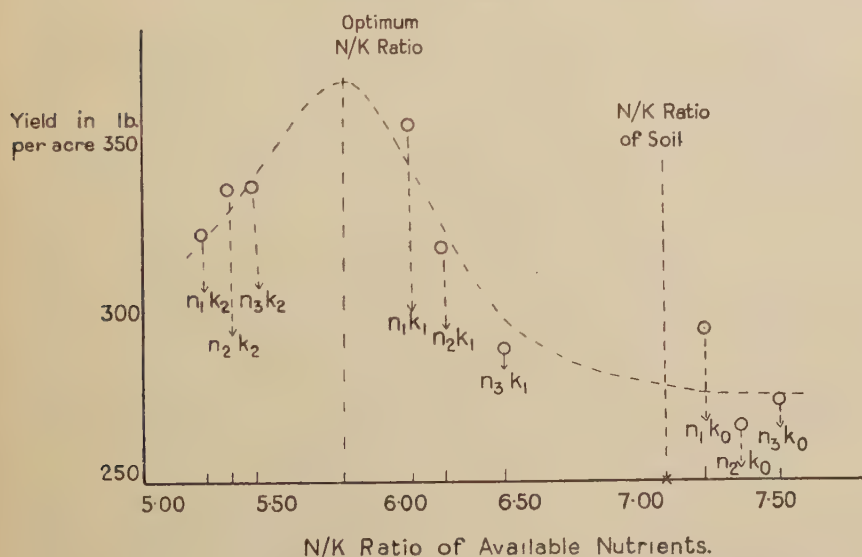
In the trial under review, applications of 600 and 900 lb. of sulphate of ammonia generally depressed yields, indicating that nitrogen was no longer the limiting factor, as it had been in previous trials. Ignoring for the time being the other manurial ingredients, applications in excess of 300 lb. per acre were not justified.

The limiting factor was now potash which gave progressive yield increments with increasing doses at nearly all levels of nitrogen. There were, however, important exceptions, as when high potash occurred with low nitrogen and when low potash occurred with high nitrogen.

The statistical significance of one of the interactions suggested that the nitrogen : potash ratio of the nutrients available to the plant played an important part in determining yield responses.

Using the results of soil sample analyses, and the fertilizer analyses, it was possible to determine per acre of the top 6" of soil, the total available quantities of nitrogen and potash and hence the N/K ratio of available nutrients corresponding to each mean yield. These are plotted in the graph below.

Effect of N/K ratio of Available Nutrients on Yield of Cotton



Low N/K Ratio	High N/K Ratio	Very High N/K Ratio
N increases Yield	N decreases Yield	N fur. decreases Yield

N increasing ---->

<----K increasing

The general form of the yield curve is indicated. It is clear that yields increased in step with the N/K ratio to a certain point after which they declined, sharply at first, as the N/K ratio increased further. When the N/K ratio was low, additions in excess of 300 lb

per acre basal dressing increased yields, but when the N/K ratio of available nutrients exceeded a value of approximately 5.8 similar increases reduced yields.

The N/K ratio of the soil itself was 7.1 and it is of great interest to note that beyond this point, the yield for the $N_1 K_0$ treatment departed considerably from the yield curve and gave a yield considerably in excess of that expected from the available N/K ratio. This finding is in accord with those of previous trials, which showed that increases in yield due to nitrogen were obtainable in spite of the high N/K ratio of the soil itself. It can only be attributed to the limiting nitrogen content of the soil itself. It is now clear that the N/K ratio of the available nutrients becomes of importance only when the initial nitrogen deficiency of the soil has been amended.

Conclusions.—Previous trials on this soil have indicated that profitable increases in yield followed the application of 300 lb. sulphate of ammonia per acre. This dressing may be regarded as a soil amendment in view of the low nitrogen status of the soil as shewn by chemical analysis.

In the trial under review further applications of sulphate of ammonia had an adverse effect except when suitable quantities of potash were also supplied.

The addition of superphosphate produced no advantage and phosphate is not considered to be a limiting factor in this trial.

Significant increases in yield were obtained from the applications of potash when the nitrogen deficiency of the soil was corrected by the application of 300 lb. sulphate of ammonia per acre.

The yield responses to potash and nitrogen, assuming the application of the basal dressing of nitrogen, appeared to depend on the N/K ratio of the nutrients available to the plant. In computing this ratio the available nutrients of the soil itself must be given full weight. From a study of the data, the optimum N/K ratio for cotton appeared to be in the neighbourhood of 5.8, this figure representing the most favourable balance for effective utilization of the two nutrients under the conditions of the experiment.

As there was, possibly, an appreciable quantity of residual nitrogen in the soil from previous years' manurial applications, the optimum N/K ratio for general application may be somewhat in excess of the figure given above.

The superiority of the VH.8 variety over V.135 has again been demonstrated in this trial; a difference of 71 lb. or 24% was observed in favour of VH.8.

There was no difference between the two varieties as regards their responses to manures.

PROGRAMME FOR 1949-50.*Breeding.*

- (1) V.135 progeny row non-replicated trial.
- (2) Main VH.8 breeding trial.
- (3) VH.8 progeny rows.
- (4) VH.8 small bulks trial.

*Field**Experiments.*

- (1) Full scale inorganics *versus* organics manurial trial with time of application treatments.
- (2) District NPK manurial trials.
- (3) Continuation of $3 \times 3 \times 3 \times 2$ experiment with particular reference to N and K.

[Included by courtesy of the Queensland Government.]

QUEENSLAND.

REGIONAL EXPERIMENTAL STATION, BILOELA. PROGRESS REPORT FOR THE SEASON 1948-49.

BY

R. W. PETERS.

INTRODUCTION.

The progress report on the cotton investigations conducted at this Experiment Station during the 1948-49 season has been prepared from the reports submitted by Messrs. W. A. R. Cowdry, R. W. George, W. H. Cairns and G. S. Daniels.

Following good rainfall in late autumn and early winter, the spring was very dry with September colder than usual—five frosts being recorded. Planting rains were not received until November. The rainfall of December and January was well below normal and as planting rains were light rain-grown cotton made little development until after cyclonic rains in February which were followed by heavy rains in March. The rank growth produced by these rains further delayed fruiting and the comparatively early frosts and cold weather experienced in April and May considerably reduced the ultimate yields of the rain-grown cotton and some of the irrigation experiments, especially late planted crops.

Table I presents the more pertinent data for the season :—

TABLE I.

<i>Crop.</i>	<i>Planting Dates.</i>	<i>Picking Dates.</i>	<i>Legal Close Season.</i>	<i>Rainfall</i> 1/7/48—30/6/49	<i>Mean Temperature</i> Oct. and Nov.	<i>Mean Yield Lint</i> <i>per Acre.</i>
Rain-grown cotton	2—23 Nov. 1—10 Dec.	March to July.	Nil	26.17 inches.	Max. 90.8°F. Min. 57.7°F.	178 lb. 108 lb. <i>Total 34 acres.</i>
Irrigated cotton ...	15—21 Oct.	March to July.	Nil	26.17 inches + 2-5 applications of 3 inches each per acre.	Max. 90.8°F. Min. 57.7°F.	458 lb. <i>Total 8.4 acres.</i>

METEOROLOGY.

The total amount of rainfall received between 1st July, 1948, and 30th June, 1949, was 26.17 inches—1.59 inches less than the 25 year mean—but the crop season (1st June to 31st May) experienced a slightly higher total than the mean, namely 28.48 as against 27.79 inches. The crop seasonal total was received in 60 wet days, which when compared with the mean of 74.1 days for this period shows how large some of the daily recordings were. Rainfall in July totalled 0.32 inches above the 26 year mean (1924-49) but from August to February the rainfall was considerably below each monthly mean. The total amount of erosive rain (0.40 inches and over per hour) was

much less than in previous years, being 28 per cent. compared with the mean of 36.8 per cent. for 11 seasons. Medium rains accounted for about the normal proportion but slow rains accounted for 56 per cent. of the total for the season compared with the mean of 48 per cent. Temperatures in November, December and February were higher than usual, with March characterised by cool days and above normal nights. April, May and June tended to have lower temperatures throughout the whole day. The highest screen maximum was 101.5° F. on February 5th while the lowest grass minimum reached 16.9° F. on June 23rd. The last frost for 1948 occurred on September 10th and the first for 1949 was recorded on May 7th, thus giving a growing season of 238 days. There were more June frosts in 1948 than the average for 23 years but they were not more intense than normal.

AGRICULTURAL PRACTICES.

The season for rain-grown cotton was unsatisfactory. The plants were stunted in their early growth, but developed long vegetative branches following the late summer rains. As a consequence the small crop of bolls which developed close to the ground was too low to be picked by the mechanical harvester. This loss partly explains the relatively small yields obtained in most rain-grown trials. The earlier planted cotton under supplementary irrigation gave better yields owing to the production of a greater number of bolls prior to the slowing down of growth in the hot dry period in late January. It was abundantly clear, however, that in such a season ample irrigation was necessary during the early summer to maintain steady plant development and to set a crop that would mature before the occurrence of the early frosts.

Mechanical Harvesting.—Thirty two acres of cotton on the Experiment Station were harvested by the Rust Bros. mechanical picker. In bulk areas the machine picked an average of 0.85 acres per hour while actively working. In fairly rank cotton plants it was found necessary to repick the row by running the machine in the reverse direction. All bolls were open and foliage had been frosted at the time of harvesting. The results indicated that picking at the optimum time for the first picking in good crops, and a second time after the plants had been frosted would allow of higher grades of better quality fibre being obtained from the greater portion of the crop.

Machine picked cotton carried less stain than did hand picked cotton and was graded Middling 1 inch. This grade was applicable to all varieties harvested and although somewhat leafy, most of the leaf was eradicated in the cleaning operations preparatory to ginning. Comparable hand picked samples were graded Middling light spot 1 inch and although carrying less leaf than machine picked cotton were of a duller colour and contained more stained lint. Slight ropiness of the fibres in machine picked cotton, which existed in past years and particularly last season, was not in evidence.

Machine picked cotton had an average ginning percentage of 34.4 compared with 33.2 for comparable hand picked cotton, the difference probably being due to the fact that the machine picked fewer immature and diseased locks than the hand pickers. Comparisons between hand picking and machine picking in a block of three varieties gave the following percentages of efficiency for the machine :—

<i>Variety.</i>	<i>Yield lb. s/c per acre—hand picked.</i>	<i>Machine picking expressed as percentage of yield of comparable hand picked cotton.</i>
Triumph	1341	78
Miller	1478	87
New Mexico Acala	569	97

The low percentage for machine picked Triumph is explained by the fact that because of the early maturity of this variety a considerable number of locks had fallen to the ground by harvest time. The high percentage picked in New Mexico Acala is probably the result of the longer staple and excellent drag which this variety has and also the fact that its foliage is glabrous and therefore does not stick to the fibres. The operations of the mechanical harvesters—both the Rust Bros. and the International Harvester—have been most successful and investigations have shown that under suitable conditions between 85 per cent. and 95 per cent. of the crop can be satisfactorily picked.

IRRIGATION INVESTIGATIONS.

The investigations comprised a continuance of the following experiments—time and rate of spray irrigation, a combined varietal and rotation experiment, a trial of strains of Miller evolved in the breeding programme for jassid resistant cottons, a varietal trial of quick maturing varieties suitable for mechanical harvesting and a pest control experiment. Seasonal conditions were suitable for cotton growing under supplementary irrigation and moderately good yields were obtained in most experiments.

Time and Rate of Spray Irrigation Experiment.—This was planted on the 15th October as a 6×4 randomised block experiment. Moisture investigations at planting time revealed an average depth of 41–55 inches of soil wet to field capacity. No severe stress conditions were experienced in any treatment, although only scattered rainfall was received up to the middle of February. However, the plants which were watered in November and December grew more vigorously, produced more flowers and gave the highest yields.

Nitrate determinations taken in December revealed that the control treatment with the least number of irrigations contained the most nitrate while the early December watering had the least.

There were no significant differences between individual yields, but the mean of the three treatments receiving both a preplanting irrigation of 3 inches and a further 3 inches of irrigation during either November or early December (679 lb. lint per acre) significantly exceeded the mean

(547 lb. lint per acre) of the three treatments which received the same preplanting irrigations but no further applications until early January. The best yield (722 lb. lint per acre) was obtained where a three inch irrigation was applied in the third week of November, when the plants were 5-6 inches tall, whereas delaying this watering until mid-December produced 629 lb. lint per acre. The leading treatment received four 3 inch spray applications plus 20.65 inches of rain during the main growing period.

Combined Varietal and Rotation Experiments.—The experiment this season included irrigated and rain-grown sorghum, irrigated and rain-grown Rhodes grass and irrigated cotton in the form of a varietal trial. The cotton yields were very variable, the average mean yield of lint being 466 lb. per acre. The two commercial varieties, Miller 610 and 41S, gave the highest yields, 582 and 524 lb. of lint per acre respectively. New Mexico Acala followed with 501 lb., the jassid resistant Millers being lowest. Irrigated and rain-grown cotton will be superimposed over the whole of this area in the coming season to test the effects of the three years cropping rotations.

Strain Trial and Time of Ploughing Experiment.—This experiment included a rain-grown strain trial superimposed on a time of ploughing of Rhodes grass experiment in which the Rhodes grass had been ploughed out at three different times during 1945 and also at three different times during 1947.

The strains consisted of the standard Miller 41S, two jassid hybrids and a jassid resistant Miller selection. There were no significant differences between the yields of any of the strains or between the original times of ploughing, but the plots which were ploughed out of grass in 1947 significantly outyielded those ploughed out in 1945. Similarly the later ploughings in each treatment tended to outyield the earlier ploughings.

In the 1947-48 season the plots where Rhodes grass was ploughed out during 1947 also significantly outyielded the plots ploughed in 1945, although the yields were somewhat lower than in 1948-49. No significant differences were recorded in any season between the different times of ploughing within the one year. There was a general tendency, however, except in this past season, for the February and March ploughings to outyield the later ploughing.

SOIL MOISTURE AND NITRIFICATION STUDIES.

A comprehensive series of studies relating to soil moisture and nitrification were again conducted in the various ages and types of cultivation used in the experimental programme.

Investigations carried out during July indicated that the average depth of moisture at field capacity in the areas intended for cotton was 35 inches, and although no outstanding differences were apparent in

the depth of moisture at this stage, areas under Rhodes grass and those where grass had been ploughed in before the June rains contained a greater depth of moisture than did the previous cotton and sorghum plots. During the dry period July to November 21st the surface soil and especially the ploughed layer dried out considerably and 2 inches of rain was required to re-wet this layer.

During the unusually dry conditions of December and the whole of January the late planted crops did not make much growth. In the case of December planted cotton especially, the root systems were not well developed before the advent of the dry weather, and consequently the plants suffered definite stress conditions during that period. The October planted cotton in the irrigation areas was well established before the dry period, however, and continued fairly normal growth although suffering some moisture stress where the January waterings were delayed. The flood rains in mid-February and early March ensured ample supplies of soil moisture in all crops to the end of the summer season; at mid-March soil moisture at field capacity existed at depths of 36-45 inches in all trials. Cotton plants used a fair proportion of this moisture during April and May and at the end of June the soil in most cotton areas was approximately half-way between wilting point and field capacity in the top 12-18 inches and approximately at full capacity in the 20-40 inch layer, thus providing a reasonable reserve of soil moisture for the following season.

The dry spring and early summer were not conducive to very high nitrate readings, but in general they could be regarded as above average. The contents rose fairly sharply during early December but from January onwards utilisation gradually overtook the rate of production. It was again recorded that irrigated plots contained a lower nitrate content than did companionate rain-grown plots. Also the plots following Rhodes grass had a much lower content than those following cotton.

COTTON BREEDING.

Owing to the transfer of the Cotton Breeder to other activities, the cotton breeding work consisted mainly of refining some of the more advanced strains of resistant Millers, multiplication of seed stocks and further testing for jassid resistance.

STRAIN TRIALS.

Irrigation trials were continued of hybrids evolved in the cotton breeding programme to supply jassid resistant cottons. The test consisted of eight strains in an 8×4 randomised block trial planted on 18th and 19th October following a preplanting irrigation of three inches. Two subsequent waterings were given, each of three inches. The mean average yield was 475 lb. lint per acre. No significant

differences were obtained although the three highest yielders were hybrids followed by the standard Miller 41S which produced 487 lb. per acre. Unfortunately no jassid infestations occurred during the growing season.

The introduction of the mechanical harvester into Queensland to relieve the acute shortage of rural labour, and the success which has been achieved in the preliminary tests of both the Rust Bros. and International Harvester Co. machines has necessitated the examination of the merits of varieties for machine harvesting. For this purpose a plant which matures most of its crop together and has an open habit of growth is necessary. A similar varietal test to that inaugurated last year at the Station was continued in the 1948-49 season with the addition of two more varieties, making the experiment a 7×4 randomised block trial composed of commercial varieties and tested strains considered suitable for the fertile alluvial soils under supplementary irrigation. The trial was planted on 21st October following a preplanting watering of 3 inches. No significant differences were obtained, but a Miller hybrid jassid resistant strain yielded 429 lb. lint per acre followed by the commercial Miller 41S with 416 and New Mexico Acala with 415. The average mean yield was 400.4 lb. lint per acre. All varieties showed plant structural characteristics suitable for mechanical harvesting and there were no outstanding differences.

ENTOMOLOGY.

A continuation of the experimental work on the control of *Heliothis armigera* Hbn. was carried out in the form of a "Student" comparison of control and the use of 0.4 per cent. DDT spray according to the following schedule :—

First spray when plants were 3 inches tall, i.e. early November.

Second spray third week in November.

Third spray mid-December.

Fourth spray mid-January.

The experiment was planted on 26th October following a pre-planting watering. After the first spraying a slight infestation of *Heliothis* on both treated and untreated plots was noticed but in December the presence of *Heliothis* was recorded in the control plots only. At the time of the final spraying in January a light infestation was noticed over the whole area. A slight delay in the last irrigation reduced yields somewhat and may have affected the second picking in the treated area. The final pickings gave the following results :—

Treatment.	First Pick Seed Cotton per acre.	Second Pick Seed Cotton per acre.	Total Pick Seed Cotton per acre.
Control	686.8 lb.	435.4 lb.	1122.2 lb
Sprayed 0.4 per cent. DDT	829.9	377.5	1207.4
Analyses	Highly sign.	Not sign.	Not sign.

PROGRAMME FOR 1949-50.

The proposed programme for 1949-50 embraces the following investigations.

Plant Breeding.—Further multiplication and roguing of leading strains and hybrids bred by Mr. Marriott.

Agronomic and Varietal experiments.—A continuation of the general programme planted in the 1948-49 season with amplifications in certain directions.

New work will include :—

- (a) The continuance of the time and rate of spray irrigation experiment on old cultivation following grain sorghum to test the applicability of the past findings of this experiment to cotton grown in rotation with annual croppings on old cultivations.
- (b) Mechanical harvesting of a range of varieties that have produced satisfactory plant structure under supplementary irrigation.
- (c) Comparison of the residual effects, on following cotton crops grown with and without irrigation, of three years growth of Rhodes grass grown with and without supplementary irrigation and of an annual rotation of similar duration of grain sorghum and cotton.

Entomology.—Insecticidal experiment on irrigated cotton to test the merits of the following sprays for the control of *Heliothis armigera* Hbn. :—0.4 per cent. DDT, 0.2 per cent. DDT plus 0.0075 E605, and 0.015 per cent. E605.

EMPIRE COTTON GROWING CORPORATION

12, Chantrey House, Eccleston Street, S.W.1.

List of Publications issued to date. Those still in print can be obtained direct from the Corporation at the above address. Those out of print are marked with an asterisk. The prices include postage.

GENERAL AND TERRITORIAL

- "Cotton Growing within the British Empire and the World's Capacity for Consuming Cotton Goods." J. W. McConnel. 1921. Price 2s.
- * "Cotton Growing in Nigeria." Sir Hector Duff. 1921.
- "The Extension of Cotton Cultivation in Tanganyika Territory." Major Hastings Horne. 1922. Price 2s.
- * "Cotton Cultivation in Nyasaland." H. C. Sampson. 1922.
- * "Cotton Growing within the British Empire." L. G. Killby. 1924.
- "Cotton Growing in South Africa." G. F. Keatinge. 1925. Price 2s.
- "A Cotton Research Station for the British Empire." Professor J. B. Farmer and Mr. L. G. Killby. 1925. Price 2s.
- "Report on the Cotton-Growing Industry in Uganda, Kenya, and the Mwanza District of Tanganyika." Col. C. N. French. 1925. Price 1s. 3d.
- "Memorandum by the Mechanical Transport Sub-Committee." Mr. G. H. Baillie, Mr. R. H. Brackenbury, Col. C. N. French, 1925. Price 2s.
- "Report on the Cotton-Growing Industry of Nigeria 1926." Col. C. N. French. 1926. Price 2s.
- * "The Principles and Practice of Yield Trials." F. L. Engledow and G. Udny Yule. 1926.
- "Report on Suitable Rotation Crops for Cotton." H. C. Sampson. 1927. Price 1s.
- "Cotton Growing in Southern Africa and the Rhodesias." Report on a Tour undertaken by Sir James Currie, Mr. J. S. Addison, and Mr. H. C. Jefferys. 1927. Price 2s.
- * "Reports from Turkestan Plant Breeding Station, Tashkent." 1928.
- "Review of the Situation in the Principal Cotton-Growing Territories of the Empire, and a Summary of the Main Activities of the Corporation since their Formation." 1928. Price 9d.
- "Report on Cotton Breeding and Seed Supply in Nigeria, 1928." F. L. Engledow and C. N. French. Price 2s.
- * "Conference of Workers on Cotton-Growing Problems, held August, 1930." Papers and Discussions.
- "Conference of Workers on Cotton Growing Problems, held July, 1934." Papers and Discussions. Price 2s. 6d.
- * "The Principles and Practice of Field Experimentation." J. Wishart and H. G. Sanders. 1935.

* Out of print.

LIST OF PUBLICATIONS—*continued*.

"Cotton Pest Control Work in Southern and Central Africa and the Rhodesias." J. W. Munro. 1937. Price 2s. 6d.

"Conference of Workers on Cotton Growing Problems, held September, 1938." Report of Proceedings and Papers Submitted. Price 2s. 6d.

PROGRESS REPORTS FROM EXPERIMENT STATIONS

Seasons 1923, 1924 and (South Africa only) 1925; in one volume, price 2s. Seasons 1926-27 to 1937-38, price 2s. 6d. each; from 1938-39 onward, price 3s. each. (Seasons 1925-26, 1927-28, 1929-30, 1930-31, 1938-39, 1940-41, 1943-44, 1944-45, out of print.)

REVIEW OF THE WORK OF THE EXPERIMENT STATIONS.

Seasons 1933-34, 1934-35, J. C. Willis; 1935-36, 1936-37, W. Nowell; 1937-38, 1938-39, W. Nowell and J. W. Munro. Price 1s. 6d. each. From 1939 published triennially in one volume:—1939-40 to 1941-42, 1942-43 to 1944-45, W. Nowell. Price 2s. each.

MEMOIRS OF THE COTTON RESEARCH STATION, TRINIDAD.

Price 2s. 6d. each.

Series A: Genetics.

- * No. 1. The Inheritance of (i) Petal Spot, (ii) Pollen Colour, (iii) Corolla Colour. S. C. Harland. 1929.
- * No. 2. Studies on the Inheritance of Corolla Colour and Petal Size in Asiatic Cottons. J. B. Hutchinson. 1931.
- * No. 3. (a) Reversal of Dominance in the Interspecific Cross *G. barbadense* Linn. $\times$ *G. hirsutum* Linn. and its Bearing on Fisher's Theory of Dominance. (b) The Inheritance of Chlorophyll Deficiency in New World Cottons. S. C. Harland. (c) "Crumpled." A New Dominant in Asiatic Cottons produced by Complementary Factors. J. B. Hutchinson. 1932.
- * No. 4. The Inheritance of Anthocyanin Pigmentation in Asiatic Cottons. J. B. Hutchinson. 1933.
- * No. 5. The Mitosis and Meiosis in Diploid and Triploid Asiatic Cotton. A. Skovsted. 1933.
- * No. 6. (a) Further Experiments on the Inheritance of the Crinkled Dwarf Mutant of *G. barbadense*. S. C. Harland. (b) Two Interspecific Hybrids between Asiatic and New World Cottons. A. Skovsted. 1934.
- No. 7. The Inheritance of Leaf Shape in Asiatic *Gossypiums*. J. B. Hutchinson. 1934.
- No. 8. Further Experiments on the Inheritance of Chlorophyll Deficiency in New World Cottons. S. C. Harland. 1934.
- No. 9. (a) Some New Interspecific Hybrids in the Genus *Gossypium* L. (b) A Hybrid between *G. Davidsonii* and *G. Sturtii*. A. Skovsted. 1935.
- * No. 10. (a) Homologous Genes for Anthocyanin Pigmentation in New and Old World Cottons. (b) A Third Series of Experiments with the Crinkled Dwarf Mutant *G. barbadense* L.—The Cross *barbadense* crinkled $\times$ *hirsutum* crinkled. (c) The Inheritance of Brown Lint in New World Cottons. S. C. Harland. 1935.
- * No. 11. Chromosome Numbers in the Malvaceæ I. A. Skovsted. 1935.
- No. 12. The Inheritance of Fuzz and Lintlessness and Associated Characters in Asiatic Cottons. J. B. Hutchinson. 1935.

* Out of print.

LIST OF PUBLICATIONS—continued.

- No. 13.** Some Observations in the Inheritance of Form and Size in Asiatic Cottons. J. B. Hutchinson. 1936.
- * **No. 14.** Chromosome Conjugation in Interspecific Hybrids. A. Skovsted. 1937.
- No. 15.** (a) The Genetics of Leaf Shape in Diploid Cottons and the Theory of Gene Interaction. (b) The Genetics and Taxonomic Distribution of some specific Lint Quality Genes in Asiatic Cottons. R. A. Silow. 1939.
- * **No. 16.** (a) The Genetic Interpretation of Plant Breeding Problems. J. B. Hutchinson. (b) Inheritance of Quantitative Characters and Plant Breeding. V. G. Panse. 1940.
- No. 17.** The Comparative Genetics of *Gossypium anomalum* and the Cultivated Asiatic Cottons. R. A. Silow. 1941.
- * **No. 18.** Anthocyanin Pattern in Asiatic Cottons, R. A. Silow and C. P. Yu. 1942.
- * **No. 19.** Colchicine-Produced Polyploids in *Gossypium*. (i). An Autotetraploid Asiatic Cotton and certain of its Hybrids with Wild Diploid Species. S. G. Stephens. 1943.
- * **No. 20.** The Efficiency of Progeny Row Breeding in Cotton Improvement. J. B. Hutchinson and H. L. Manning. 1943.
- * **No. 21.** The Inheritance of Lint Colour in Asiatic Cottons. R. A. Silow. 1944.
- * **No. 22.** The Genetic Organization of Leaf-Shape Development in the genus *Gossypium*. S. G. Stephens. 1944.
- * **No. 23.** The Genetics of Species Development in the Old World Cottons. R. A. Silow. 1944.
- * **No. 24.** I. Colchicine-Produced Polyploids in *Gossypium*. (ii) Old World Triploid Hybrids. II. A Genetic Survey of the Leaf Shape in New World Cottons—a Problem in Critical Identification of Alleles. III. The modifier concept. A Developmental analysis of Leaf-Shape "modification" in New World Cottons. IV. Canalization of Gene Action in the *Gossypium* Leaf-Shape System and its bearing on certain Evolutionary Mechanisms. S. G. Stephens. 1945.
- * **No. 25.** The Sea Island Cottons. J. B. Hutchinson and H. L. Manning. 1945.
- * **No. 26.** I. The Genetics of "Corky"; (i) The New World Alleles and their possible rôle as an interspecific isolating mechanism. S. G. Stephens. II. The Crinkled Dwarf Allelomorph Series in the New World Cottons. J. B. Hutchinson. III. Evidence on Chromosome Homology and Gene Homology in the Amphidiploid New World Cottons. R. A. Silow. 1946.
- * **No. 27.** I. The Seed Hairs of *Gossypium* Species. J. B. Hutchinson, S. G. Stephens, and K. S. Dodds. II. The Inheritance of Brown Lint in New World Cottons. J. B. Hutchinson. III. On the Occurrence and Significance of Deleterious Genes in Cotton. J. B. Hutchinson. 1946.

Series B: Physiology.

- * **No. 1.** Studies on the Transport of Carbohydrates in the Cotton Plant. Parts I and II. T. G. Mason and E. J. Maskell. 1928.
- * **No. 2.** Studies on the Transport of Nitrogenous Substances in the Cotton Plant. Parts I., II. and III. E. J. Maskell and T. G. Mason. 1930.

* Out of print.

LIST OF PUBLICATIONS—*continued*.

- No. 3.** Studies on the Transport of Nitrogenous Substances in the Cotton Plant. IV. The Interpretation of the Effects of Ringing, with special reference to the Lability of the Nitrogen Compounds of the Bark. V. Movement to the Boll. E. J. Maskell and T. G. Mason. 1930.
- No. 4.** Studies on the Transport of Carbohydrates in the Cotton Plant. III. The Polar Distribution of Sugar in the Foliage Leaf. E. Phillis and T. G. Mason. 1933.
- * **No. 5.** Further Studies on Transport in the Cotton Plant. I. Preliminary Observations on the Transport of Phosphorus, Potassium and Calcium. II. An Ontogenetic Study of Concentrations and Vertical Gradients. T. G. Mason and E. J. Maskell. 1934.
- No. 6.** Studies on the Transport of Nitrogenous Substances in the Cotton Plant. VI. Concerning Storage in the Bark. T. G. Mason and E. Phillis. 1934.
- * **No. 7.** Further Studies on Transport in the Cotton Plant. III. Concerning the Independence of Solute Movement in the Phloem. T. G. Mason, E. J. Maskell and E. Phillis. IV. On the Simultaneous Movement of Solutes on Opposite Directions through the Phloem. E. Phillis and T. G. Mason. 1936.
- No. 8.** Further Studies on Transport in the Cotton Plant. V. Oxygen Supply and the Activation of Diffusion. T. G. Mason and E. Phillis. Concentration of Solutes in Sap and Tissue, and the Estimation of Bound Water. T. G. Mason and E. Phillis. 1936.
- No. 9.** Further Studies on Transport in the Cotton Plant. VI. Interchange between the Tissues of the Corolla. E. Phillis and T. G. Mason. 1936.
- No. 10.** The Effect of Light and of Oxygen on the Uptake of Sugar by the Foliage Leaf. E. Phillis and T. G. Mason. 1937.
- No. 11.** Experiments on the Extraction of Sap from the Vacuole of the Leaf of the Cotton Plant, and their bearing on the Osmotic Theory of Water Absorption by the Cell. T. G. Mason and E. Phillis. Studies on the Partition of the Mineral Elements in the Cotton Plant. (i) Preliminary Observations on Nitrogen and Phosphorus. E. Phillis and T. G. Mason. 1939.
- No. 12.** Further Studies on Transport in the Cotton Plant. VII. Simultaneous Changes in the Production and Distribution of Dry Matter under Varying Potassium Supply. E. Phillis and T. G. Mason. 1939.
- No. 13.** (a) The Effect of Ringing in the Upward Movement of Solutes from the Root. (b) The Effect of Ringing and of Transpiration on Mineral Uptake. E. Phillis and T. G. Mason. 1940.
- No. 14.** Concerning the Upward Movement of Soil Solutes. T. G. Mason and E. Phillis. Studies on the Partition of the Mineral Elements in the Cotton Plant. (ii). Preliminary Observations on Potassium, Calcium and Magnesium. E. Phillis and T. G. Mason. On the Expression of Sap by Low Pressure. E. Phillis and T. G. Mason. 1941.
- No. 15.** I. On Diurnal Variations in the Mineral Content of the Leaf of the Cotton Plant. E. Phillis and T. G. Mason. II. Studies on Foliar Hydration in the Cotton Plant. (i) The Effects of Potassium Supply and Size of Plant. (ii) Preliminary Observations using the Disc Culture Method. T. G. Mason and E. Phillis. III. Studies on the Partition of the Mineral Elements in the Cotton Plant. (iii) Mainly concerning Nitrogen. E. Phillis and T. G. Mason. 1943.

* Out of print.

LIST OF PUBLICATIONS—*continued*.

- No. 16.** I. Studies on Foliar Hydration in the Cotton Plant. (iii) Preliminary Observations using the Pruning Method. E. Phillis and T. G. Mason. (iv) The Influence of Composition and Concentration of Nutrient Solution. T. G. Mason and E. Phillis (v) A Further Experiment with Potassium. E. Phillis and T. G. Mason. II. Studies on the Partition of the Mineral Elements in the Cotton Plant. (iv) More about Nitrogen, Phosphorus, and Labile Carbohydrate. T. G. Mason and E. Phillis. 1944.
- No. 17.** I. Studies on Foliar Hydration in the Cotton Plant—(vi) A Gel Theory of Cell Water Relations. E. Phillis and T. G. Mason. II. The Effect of Ringing and of Transpiration on Mineral Uptake. A Reply to Criticism. T. G. Mason and E. Phillis. III. Studies on the Partition of the Mineral Elements in the Cotton Plant. (v) An Adsorption Theory of Nitrogen Regulation. T. G. Mason and E. Phillis. IV. The Effect of Extreme Desiccation on the Viability of Cotton Seed. E. Phillis and T. G. Mason. 1946.
- No. 18.** Studies on Foliar Hydration in the Cotton Plant. (vii) The Size Factor. T. G. Mason. 1947.
-

EMPIRE COTTON GROWING CORPORATION

RESEARCH MEMOIRS.

Price 2s. 6d. each.

- No. 1.** Breeding Cotton Resistant to Blackarm Disease. R. L. Knight 1946.
- No. 2.** Notes on the Classification and Distribution of Genera related to *Gossypium*. J. B. Hutchinson. 1947.
- No. 3.** The Role of Major Genes in the Evolution of Economic Characters. R. L. Knight. 1948.
- No. 4.** The Development of Internal Boll Disease of Cotton in Relation to Time of Infection. E. O. Pearson. 1948.
- No. 5.** Observations on the Development of the Cotton Boll, with Particular Reference to Changes in Susceptibility to Pests and Diseases. R. C. Rainey. 1948.
- No. 6.** Experimental Methods with Cotton.—Sulphuric Acid Treatment of Cotton Seeds. Effects of Gap-filling on Development and Yield. D. MacDonald, W. L. Fielding and D. F. Ruston. Ginning Percentage and its Determination in Variety Trials. Determination of Staple Length in Single Plant Selections and Variety Trials. W. L. Fielding. 1948.
- No. 7.** Jassid Resistance and Hairiness of the Cotton Plant. F. R. Parnell, H. E. King and D. F. Ruston. 1949.
-

EMPIRE COTTON GROWING REVIEW.

“The Empire Cotton Growing Review” is the official organ of the Empire Cotton Growing Corporation. It is published quarterly (in January, April, July and October) and contains original articles, reviews, and notes on scientific, commercial and technical literature. The price of each issue is 1s. 3d. post free (2s. 6d. from January, 1951), and copies may be obtained from the publishers, Messrs. Staples Press Ltd., 14 Great Smith Street, London, S.W.1.

OVERSEAS STAFF

CENTRAL COTTON RESEARCH STATION

NAMULONGE, UGANDA

Director	-	-	-	Dr. J. B. HUTCHINSON, C.M.G.
Plant Breeding	-	-	-	Mr. D. MACDONALD
" "	-	-	-	Mr. H. L. MANNING
Crop Husbandry	-	-	-	Mr. A. N. PRENTICE
" "	-	-	-	Mr. H. G. FARBROTHER
Entomology	-	-	-	Mr. E. O. PEARSON
Plant Pathology	-	-	-	Dr. G. M. WICKENS
Secretary	-	-	-	Mr. A. H. FISH, M.B.E.
Farm Manager	-	-	-	Mr. A. L. STEPHENS, M.B.E.
Assistant Farm Manager	-	-	-	Mr. B. E. M. PETIT

SHAMBAT, SUDAN

Cytogenetics	-	-	-	Dr. H. DOUWES
"	-	-	-	Mr. R. L. CUANY

ANGLO-EGYPTIAN SUDAN

WAD MEDANI

Plant Breeding	-	-	-	Mr. R. R. ANSON
" "	-	-	-	Mr. K. C. BARLOW

SHAMBAT

Genetics	-	-	-	Dr. R. L. KNIGHT
"	-	-	-	Mr. J. E. W. SADD

KADUGLI

Plant Breeding	-	-	-	Mr. M. F. ROSE
----------------	---	---	---	----------------

TANGANYIKA TERRITORY

UKIRIGURU

Plant Breeding	-	-	-	Mr. J. E. PEAT
" "	-	-	-	Mr. J. M. MUNRO

KILOSA

Plant Breeding	-	-	-	Mr. A. G. BEBBINGTON
Entomology	-	-	-	Mr. H. J. DE S. DISNEY

NYASALAND

Plant Breeding	-	-	-	Mr. H. C. DUCKER
" "	-	-	-	Mr. W. L. MILLER
" "	-	-	-	Mr. S. H. EVELYN
" "	-	-	-	Mr. M. S. HASTIE

NIGERIA

Plant Breeding	-	-	-	Mr. H. E. KING
Entomology	-	-	-	Mr. Q. A. GEERING

WEST INDIES

ANTIGUA

Cotton Officer in the West Indies	Mr. J. V. LOCHRIE, O.B.E.
-----------------------------------	---------------------------

